EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
18.11.2009 Bulletin 2009/47

(21) Application number: 06736793.8

(22) Date of filing: 02.03.2006

(51) Int Cl.:
C08L 67/02 (2006.01)

(86) International application number:
PCT/US2006/007531

(87) International publication number:
WO 2006/094165 (08.09.2006 Gazette 2006/36)

(54) TRANSPARENT, OXYGEN-SCAVENGING COMPOSITIONS AND ARTICLES PREPARED THEREFROM
TRANSPARENTE SAUERSTOFFFÄNGERZUSAMMENSETZUNGEN UND DARAUS HERGESTELLTE GEGENSTÄNDE
COMPOSITIONS TRANSPARENTES PIEGEANT L’OXYGENE ET ARTICLES PREPARES A PARTIR DE CELLES-CI

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR

(30) Priority: 02.03.2005 US 657746 P
27.02.2006 US 363374

(43) Date of publication of application:

(60) Divisional application:
08012673.3 / 1 985 664

(73) Proprietor: EASTMAN CHEMICAL COMPANY
Kingsport TN 37660 (US)

(72) Inventors:
- HALE, Wesley, Raymond
  Kingsport, Tennessee 37663 (US)
- PECORINI, Thomas, Joseph
  Kingsport, TN 37663 (US)
- STEWART, Mark, Edward
  Kingsport, TN 37664 (US)
- ROGERS, Martin, Emerson
c/o EASTMAN CHEMICAL COMPANY
  Kingsport, TN 37660 (US)
- GILLIAM, Spencer, Allen
  Kingsport, TN 37660 (US)
- CLIFFTON, Michael, Duane
  Kingsport, TN 37663 (US)
- SHELBY, Marcus David
  Fall Branch, Tennessee 37656 (US)

(74) Representative: Wibbelmann, Jobst et al
Wuesthoff & Wuesthoff
Patent- und Rechtsanwälte
Schweigerstrasse 2
81541 München (DE)

(56) References cited:
EP-A- 0 318 964
WO-A-01/09245

- YOSHITSUGU MARUHASHI AND SETSUKO IIDA:
  "Transparency of Polymer Blends" POLYMER ENGINEERING AND SCIENCE, vol. 41, no. 11,
  November 2001 (2001-11), pages 1987-1995,
  XP002385265

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).
Description

CROSS REFERENCES TO RELATED APPLICATIONS

FIELD OF THE INVENTION

This invention pertains to transparent, oxygen-scavenging polymer compositions. More specifically, this invention pertains immiscible polymer blends comprising an oxidation catalyst, at least one thermoplastic polymer, and a copolyamide or a homogeneous blend of at least two polyamides in which the different phases of the immiscible blend have small differences in the absolute value of their refractive indices. This Invention also pertains to shaped articles comprising the oxygen-scavenging compositions.

BACKGROUND OF THE INVENTION

Many products, in particular food products, are sensitive to the presence of oxygen and the loss or absorption of water. Packaged products with this sensitivity are susceptible to deterioration because of exposure to oxygen or absorption of moisture. Packaging materials which limit oxygen exposure to food articles, for example, help to maintain the quality of the food articles and to reduce spoilage. The use of such barrier packaging thus keeps the article in inventory longer and thereby reduces restocking costs and waste. Attempts to solve this problem have led to the widespread use of oxygen barriers and/or moisture barriers in packaging materials. Many polymeric materials are known to act as barriers to oxygen or moisture. For example, typical moisture barriers include polyethylene and polypropylene. Representative oxygen barriers include poly(ethylene vinyl alcohol) ("EVOH"), poly(vinyl alcohol) ("PVOH"), polyamides (nylons), and blends of these materials. Poly(vinylidene chloride), vinyl chloride copolymers, and vinylidene chloride-methyl acrylate copolymers also are useful as moisture and oxygen barriers.

These conventional barrier materials, however, are expensive and have unstable structural characteristics or other deficiencies that make fabrication of packaging materials solely out of barrier materials difficult or undesirable. For example, EVOH, while having superior oxygen barrier properties, is not effective as a moisture barrier. Other barrier materials are prohibitively expensive to be used solely as a packaging material. To avoid these problems, it has become a common practice to use multilayer structures in which the amount of expensive barrier material may be reduced to a thin layer and used in conjunction with an inexpensive polymer on one or both sides of the barrier layer as structural layers. The use of multilayer structures also helps to protect the barrier layer from deterioration by structural layers. Multilayer products, however, can be expensive to produce. Further, multilayer articles can present difficulties in recycling because the different polymer components are difficult to separate. In addition, blending the recovered scrap polymer or "regrind" with virgin polymer often will cause unsatisfactory haze or opaqueness because of the incompatibility of the virgin materials with the regrind.

The shortcomings of conventional barrier polymers also may be overcome by using a blend of the barrier polymer with another polymer. Unfortunately, as noted above, many blends of barrier polymers and other thermoplastic polymers are immiscible and are opaque or hazy. Such blends are not satisfactory for applications requiring clarity such as, for example, beverage containers.

Polyester polymers such as, for example, poly(ethylene terephthalate) ("PET"), are commonly used in packaging applications. PET has a number of properties that make it useful as a packaging material, including acceptable carbon dioxide barrier properties for soft drinks packaged in bottles containing multiple servings. However, improvements in the carbon dioxide barrier of PET are needed for soft drinks packaged in smaller bottles and in its oxygen barrier, which is not well-suited for packaging oxygen sensitive products such as, for example, beer, citrus products, tomato-based products, and aseptically packed meat. Poly(ethylene naphthalate) ("PEN") is 3-10 times more effective as a barrier than PET but is more expensive.

Multilayer structures can be used to improve the gas barrier characteristics of PET. For example, polymers that have excellent oxygen barrier (also referred to as "passive barrier") or scavenging properties (also referred to as "active barrier") may be combined with PET to produce a layered structure consisting of the individual polymers. These multilayer structures, however, are expensive to produce. Blends of barrier polymers with PET also have been used to improve the oxygen barrier of packages but, as noted above, often have poor transparency and are not suitable for many packaging applications. The poor transparency of blends also makes it difficult to recycle manufacturing scrap from polymer blends into virgin polymer.

Copolyester films and extrusion blow molded ("EBM") bottles are often desired for toughness, and are commonly used instead of PET for extrusion blow molding and film applications. These applications often require barrier that is comparable to that of oriented PET. Unfortunately, however, the barrier properties of copolymesters are inferior to oriented PET. Multilayer structures can be produced by coextruding a thin, barrier film into the center of a thicker bulk structure to improve the overall barrier. To be economical, however, EBM and film processes typically require that high levels (up
to 80%) of regrind (i.e., flash and trim) are reprocessed. Unfortunately, typical barrier materials are not miscible with copolysters and blends of these barrier polymers with polyesters often show a high level of haze and poor clarity. The haze level of the overall film structure, therefore, is increased to unacceptable levels when scrap polymer (i.e., regrind) is incorporated back into the primary layer.

A polymer blend that provides good passive and/or active barrier properties, is economical, and can be recycled efficiently is needed in the art. Such blends should be transparent, contain thermoplastic and barrier polymers that provide a high barrier for oxygen, water, and carbon dioxide, and can be used economically in article forming processes which incorporate a high level of regrind. In addition, there is need for barrier and thermoplastic polymer compositions that can be used to economically produce multilayered articles having high transparency and can tolerate a high level of regrind.

SUMMARY OF THE INVENTION

Polymer compositions having high transparency and high barrier properties can be prepared from an immiscible blend of one or more thermoplastic polymers and a copolyamide or a homogeneous, transamidized blend of at least 2 polyamides in which the difference in refractive index between the polyamide component and thermoplastic polymer component is about 0.006 to about -0.0006. Thus, the present invention provides a polymer composition, comprising an immiscible blend of:

(i) a first component comprising at least one thermoplastic polymer selected from polyesters, polycarbonates, polarylates, and homogeneous blends thereof; and
(ii) a second component comprising a homogeneous, transamidized blend of at least 2 polyamides;

wherein the second component (ii) and the first component (i) have a difference in refractive index, $RI_{(second\ component)} - RI_{(first\ component)}$, of about 0.006 to about -0.0006, and the immiscible blend has a percent transmittance of at least 75%, and a haze of 10% or less.

The first component comprises at least one thermoplastic polymer selected from polyesters, polycarbonates, polarylates, and homogeneous blends of these polymers, while the second component comprises a blend of at least 2 polyamides which have been transamidized to produce a homogeneous blend. We have discovered that refractive indices of the first and second components can be closely matched by selecting at least 2 polyamides having different levels of aliphatic and aromatic residues and transamidizing these polyamides to form a homogeneous blend. Thus, homogeneous blends of the thermoplastic polymers and the polyamides can be used to tailor refractive indices of the second component and the first component to within their desired ranges such that the difference in refractive indices is about 0.006 to about -0.0006. For example, a homogeneous blend of a polyester and a polycarbonate comprising the residues of bisphenol A can be used as the first component and a transamidized, homogeneous blend of first polyamide comprising the residues of m-xylendiamine and adipic acid, and a second aliphatic polyamide can be used as the barrier polymer. When the refractive indices are thus matched, the first and second components form clear, immiscible blends that are suitable for the preparation of high clarity, shaped articles that can be used in many packaging applications. Multilayered articles may also be prepared by a variety of processes known in the art. For example, the first and second components may be coextruded or coinjected from the melt into separate layers, or the layers may be formed individually and brought together in a subsequent process such as, for example, lamination.

The second component can also comprise a copolyamide having a ratio of aromatic and aliphatic dicarboxylic acid and diamine residues that can be varied to closely match the refractive indices of the first and second components. Thus, another aspect of the invention is a polymer composition, comprising an immiscible blend of:

(i) a first component comprising at least one thermoplastic polymer selected from polyesters, polycarbonates, polarylates, and homogeneous blends thereof; and
(ii) a second component comprising a copolyamide;

wherein the second component (ii) and the first component (i) have a difference in refractive index, $RI_{(second\ component)} - RI_{(first\ component)}$, of about 0.006 to about -0.0006, and the immiscible blend has a percent transmittance of at least 75%, and a haze of 10% or less.

Another aspect of our invention is a polymer composition, comprising an Immiscible blend, prepared by a process comprising melt blending:

(i) a first component comprising at least one thermoplastic polymer selected from polyesters, polycarbonates, polarylates, and homogeneous blends thereof; and
(ii) a second component comprising a homogeneous, transamidized blend of at least 2 polyamides;
The compositions of our invention show excellent barrier properties. The oxygen barrier properties may be enhanced by incorporating transition metal catalysts such as, for example, cobalt, manganese, iron, ruthenium, copper, nickel, palladium, and platinum into the blends to produce oxygen scavenging compositions. The invention, thus, further provides an oxygen-scavenging composition comprising:

(A) an immiscible blend comprising

(i) first component comprising at least one thermoplastic polymer selected from polyester, polycarbonate, polyarylate, and homogeneous blends thereof; and
(ii) a second component comprising a transamidized, homogeneous blend of at least two polyamides;

wherein the second component (ii) and the first component (i) have a difference in refractive index, RI(second component) - RI(first component), of about 0.006 to about -0.0006, and the immiscible blend has a percent transmittance of at least 75%, and a haze of 10% or less; and
(B) at least one metal selected from Groups 3-12, Rows 4-6 of the Periodic Table of the Elements. Typical metal catalysts are cobalt, manganese, and iron.

The blends of the present invention are useful for producing clear, shaped articles having improved barrier properties, melt processability, and excellent mechanical properties, and which can be prepared using a high proportion of regrind to virgin polymer. These shaped articles may have a single layer or multiple layers and have numerous packaging applications. Accordingly, the invention further provides a process for forming a shaped article, comprising:

(A) melt blending

(i) a first component comprising at least one thermoplastic polymer selected from polyesters, polycarbonates, polylarylates, and homogeneous blends thereof; and
(ii) a second component comprising a copolyamide or a homogeneous, transamidized blend of at least 2 polyamides;

wherein the first component (i) and second component (ii) form an immiscible blend, the second component and the first component have a difference in refractive index, RI(second component) - RI(first component), of about 0.006 to about -0.0006, and the immiscible blend has a percent transmittance of at least 75%, and a haze of 10% or less;
(B) forming a shaped article;
(C) recovering a scrap polymer composition comprising the blended first and second components (i) and (ii) ;
(D) grinding the scrap polymer composition to produce a polymer regrind;
(E) optionally, drying the scrap polymer composition; and
(F) combining the polymer regrind with the first and second components (i) and (ii) of step (A). Examples of shaped articles which may be prepared by the process of the invention include, but are not limited to, sheets, films, tubes, bottles, or profiles. The shaped article may be produced by extrusion, calendering, thermoforming, blow-molding, extrusion blow-molding, injection molding, compression molding, casting, drafting, tentering, or blowing.

The shaped articles may have a one or more layers comprising an immiscible blend of the first and second components or can have multiple layers in which the first and second components are in separate layers. The invention also provides a multilayered, shaped article, comprising:

(i) a first layer comprising at least one thermoplastic polymer selected from polyester, polycarbonate, polyarylate, and homogeneous blends thereof; and
(ii) a second layer comprising a transamidized homogeneous blend of at least two polyamides;

wherein the second layer (ii) and the first layer (i) have a difference in refractive index, RI(second layer) - RI(first layer), of about 0.006 to about -0.0006, and the shaped article has a percent transmittance of at least 75%, and a haze of 10% or less.

The invention further provides a process for forming a multilayered shaped article, comprising:
(i) heating a first component comprising at least one thermoplastic polymer selected from polyesters, polycarbonates, polarylates, and homogeneous blends thereof to a temperature of about Tg +100°C to about Tg + 300°C of the first component;

(ii) heating a second component comprising a copolyamide or a transamidized, homogeneous blend of at least two polynamides to a temperature of about Tg +100°C to about Tg + 300°C of the second component;

(iii) forming a shaped article having the first and second components in separate layers;

(iv) recovering scrap first and second components;

(v) grinding the scrap first and second components to produce a regrind;

(vi) optionally, drying the regrind; and

(vii) combining the regrind with the first component, second component, or a combination thereof, of steps (i) and (ii);

wherein the second component of step (ii) and the first component of step (i) of have a difference in refractive index, RI (second component) - RI(first component), of about 0.006 to about -0.0006, and the shaped article has a percent transmittance of at least 75%, and a haze of 10% or less. The regrind may be incorporated into the first or second layer and may be from about 5 to about 60 weight percent of the article.

DETAILED DESCRIPTION

[0017] Polymer compositions having high clarity and good barrier properties can be prepared from an immiscible blend of one or more thermoplastic polymers and a transamidized, homogeneous blend of at least two polynamides, in which the difference in refractive index between the blend of polynamides and the thermoplastic polymers is about 0.006 to about -0.0006. The blend has a percent transmittance of at least 75%, and a haze of 10% or less. In a general embodiment, the present invention provides polymer composition, comprising an immiscible blend of:

(i) a first component comprising at least one thermoplastic polymer selected from polyesters, polycarbonates, polarylates, and homogeneous blends thereof; and

(ii) a second component comprising a homogeneous, transamidized blend of at least 2 polynamides;

wherein the second component (ii) and the first component (i) have a difference in refractive index, RI(second component) - RI(first component), of about 0.006 to about -0.0006, and the immiscible blend has a percent transmittance of at least 75%, and a haze of 10% or less. The thermoplastic polymers and polynamides may be selected from a wide variety of polymers. The refractive indices of the second component and the first component can be adjusted to give a difference of about 0.006 to about -0.0006 by the selection and ratio of the polynamides of the second component or, alternatively, by blending the thermoplastic polymers of the first component to form a homogeneous blend. Our novel compositions can be used to manufacture shaped articles having one or more layers such as, for example, sheets, films, tubes, bottles, and profiles. The shaped article may be produced by extrusion, calendering, thermoforming, blow-molding, extrusion blow-molding, injection molding, compression molding, casting, drafting, tentering, or blowing. Multilayer articles can be prepared in which the immiscible blend is present in one or more layers or the first and second components are in separate layers. Because of the small difference in the refractive indices of the first and second components, shaped articles prepared from the composition of the invention can incorporate substantial quantities of regrind and retain good transparency. The clarity and barrier properties of these shaped articles produced make them particularly useful for packaging applications.

[0018] Unless otherwise indicated, all numbers expressing quantities of ingredients, properties such as molecular weight, reaction conditions, and so forth used in the specification and claims are to be understood as being modified in all instances by the term "about." Accordingly, unless indicated to the contrary, the numerical parameters set forth in the following specification and attached claims are approximations that may vary depending upon the desired properties sought to be obtained by the present invention. At the very least, each numerical parameter should at least be construed in light of the number of reported significant digits and by applying ordinary rounding techniques. Further, the ranges stated in this disclosure and the claims are intended to include the entire range specifically and not just the endpoint(s).

For example, a range stated to be 0 to 10 is intended to disclose all whole numbers between 0 and 10 such as, for example 1, 2, 3, 4, etc., all fractional numbers between 0 and 10, for example 1.5, 2.3, 4.57, 6.1113, etc., and the endpoints 0 and 10. Also, a range associated with chemical substituent groups such as, for example, "C1 to C5 hydrocarbons", is intended to specifically include and disclose C1 and C5 hydrocarbons as well as C2, C3, and C4 hydrocarbons.

[0019] Notwithstanding that the numerical ranges and parameters setting forth the broad scope of the invention are approximations, the numerical values set forth in the specific examples are reported as precisely as possible. Any numerical value, however, inherently contains certain errors necessarily resulting from the standard deviation found in their respective testing measurements.

[0020] As used in the specification and the appended claims, the singular forms "a," "an" and "the" include their plural
referents unless the context clearly dictates otherwise. For example, reference a "polymer," or a "shaped article," is intended to include the processing or making of a plurality of polymers, or articles. References to a composition containing or including "an" ingredient or "a" polymer is intended to include other ingredients or other polymers, respectively, in addition to the one named.

[0021] By "comprising" or "containing" or "including" we mean that at least the named compound, element, particle, or method step, etc., is present in the composition or article or method, but does not exclude the presence of other compounds, catalysts, materials, particles, method steps, etc, even if the other such compounds, material, particles, method steps, etc., have the same function as what is named, unless expressly excluded in the claims.

[0022] It is also to be understood that the mention of one or more method steps does not preclude the presence of additional method steps before or after the combined recited steps or intervening method steps between those steps expressly identified. Moreover, the lettering of process steps or ingredients is a convenient means for identifying discrete activities or ingredients and the recited lettering can be arranged in any sequence, unless otherwise indicated.

[0023] The term "polyester", as used herein, is intended to include homopolymers, copolymers, and terpolymers. In general, polyesters are synthetic polymers prepared by the polycondensation of one or more difunctional carboxylic acids with one or more difunctional hydroxyl compounds. Typically, the difunctional carboxylic acid is a dicarboxylic acid or a hydroxydicarboxylic acid, and the difunctional hydroxy compound is a dihydric alcohol such as, for example, glycols and diols. In the present invention, the difunctional carboxylic acid may be an aliphatic or cycloaliphatic dicarboxylic acid such as, for example, adipic acid, or an aromatic dicarboxylic acid such as, for example, terephthalic acid. The difunctional hydroxy compound may be cycloaliphatic diol such as, for example, 1,4-cyclohexanediol, a linear or branched aliphatic diol such as, for example, 1,4-butanediol, or an aromatic diol such as, for example, hydroquinone.

[0024] The term "polyamide", as used herein, is intended to include synthetic polymers prepared by the polycondensation of one or more difunctional carboxylic acids with one or more difunctional amines or by the ring-opening polymerization of a lactams and may include homopolymers and copolymers. For example, the difunctional carboxylic acid can be a dicarboxylic acid such as adipic acid or isophthalic acid, and the difunctional amines can be a diamine such as, for example, hexamethylene diamine or m-xylylenediamine. The term "copolyamide", as used herein, is understood to mean a polyamide comprising at least 2, chemically distinct repeating units. For example, MXD6 nylon, is not a copolyamide because it contains only a single, chemically distinct repeating unit containing the residues of adipic acid and m-xylylenediamine. By contrast, poly(hexamethylene adipamide-co-isophthalamide), prepared by the condensation of hexamethylenediamine with adipic and isophthalic acid, has two chemically distinct repeating units, that is, a repeating unit containing the residues of hexamethylenediamine and adipic acid, and another repeating unit containing the residues of hexamethylenediamine and isophthalic acid.

[0025] The term "polycarbonate" is herein defined as the condensation product of a carbonate source and a diol source, having a carbonate component containing 100 mole percent carbonate units and a diol component containing 100 mole percent diol units, for a total of 200 mole percent monomeric units or 100 mole percent "repeating units". In one embodiment of the present invention, the polycarbonate portion of the first component is based upon the polycarbonate of 4,4'-isopropylidenediphenol, commonly known as bisphenol A. A polycarbonate. A wide variety of the linear or branched polycarbonates that may be utilized in the present invention may be derived from bisphenol A and can be prepared according to procedures well known in the art such as, for example, as disclosed in U.S. Patent No.'s 3,030,335 and 3,317,466. Examples of bisphenol A polycarbonates that may be used in the present invention and are available commercially include the materials marketed under the tradenames LEXAN®, available from the General Electric Company, and MAKROLON®, available from Bayer, Inc.

[0026] The term "polyarylate", as used herein, is understood to mean polyesters prepared by the polycondensation of one or more difunctional aromatic dicarboxylic acids with one or more dihydric phenols. For example, typical aromatic dicarboxylic acids are terephthalic and isophthalic acid, and typical aromatic diphensols are bisphenol A and hydroquinone.

[0027] The term "residue", as used herein in reference to the polymers of the invention, means any organic structure incorporated into a polymer through a polycondensation or ring opening reaction involving the corresponding monomer. The term "repeating unit", as used herein, means shortest sequence of monomer residues that can be found repeatedly in a polymer. For example, in polyesters, a repeating unit is an organic structure having dicarboxylic acid residue and a diol residue, or hydroxydicarboxylic acid residues bonded through a carboxyloxy group. In a polyamide, a repeating unit is an organic structure having a dicarboxylic acid and a diamine residue, lactam, or aminoacid residues, bonded through an amide group.

[0028] It will also be understood by persons having ordinary skill in the art, that the residues associated within the various polyesters, polyamide, polycarbonates, and polyarylates of the invention can be derived from the parent monomer compound itself or any derivative of the parent compound. For example, the dicarboxylic acid and amino acid residues referred to in the polymers of the invention may be derived from a dicarboxylic acid or aminoacid monomer or its associated acid halides, esters, salts, anhydrides, or mixtures thereof. Thus, as used herein, the term "dicarboxylic acid" or "aminoacid" is intended to include dicarboxylic acids and any derivative of a dicarboxylic acid, including its associated acid halides, esters, half-esters, salts, half-salts, anhydrides, mixed anhydrides, or mixtures thereof, useful in a poly-
condensation process with a diol to make a high molecular weight polyester or polyamide. "Hydroxycarboxylic acid" is intended to include aliphatic and cycloaliphatic hydroxy carboxylic acids as well as monohydroxy-monocarboxylic acids and any derivative thereof, including their associated acid halides, esters, cyclic esters (including dimers such as lactic acid lactides), salts, anhydrides, mixed anhydrides, or mixtures thereof, useful in a polycondensation process or ring opening reaction to make a high molecular weight polyester. Similarly, "aminoacid" is intended to include aliphatic, aromatic, and cycloaliphatic amino acids and any derivative thereof, including their associated acid halides, amides, cyclic amides (lactams), salts, anhydrides, mixed anhydrides, or mixtures thereof, useful in a polycondensation process or ring opening reaction to make a high molecular weight polyamide. In addition, the term "diamine" is intended to include diamines as well as their associated salts, amides, or any other derivative thereof that are useful for the preparation of polyamides.

[0029] Whenever the term "inherent viscosity" (I.V.) is used in this application, it will be understood to refer to viscosity determinations made at 25 °C using 0.5 grams of polymer per 100 ml of a solvent comprising 60 weight percent phenol and 40 weight % tetrachloroethane.

[0030] The term "refractive index" (abbreviated herein as "RI") as used herein, refers to refractive index measurements obtained according to standard methods well known in the art. The refractive indices reported herein were determined at a wavelength of 633 nm using a Metricon Prism Coupler™ model 2010 refractometer (available from Metricon Inc.) and are reported as the average of the refractive indices measured in 3 orthogonal directions (extrusion or stretch, transverse, and thickness directions). The phrase "difference in refractive index" as used herein in the context of the compositions, processes, and shaped articles of the invention always means the value obtained by subtracting the refractive index of the polyester, polycarbonate, or polylactate-containing component (typically referred to herein as the "first component" or "first layer" in multilayered articles) from the refractive index of the polyamide- or copolyamide-containing component (typically referred to herein as the "second component" or "second layer" in multilayered articles). Thus, in accordance with the invention, the difference in refractive index ("ΔRI") should be calculated according to the following formula:

\[ \Delta RI = RI \text{(second component or layer)} - RI \text{(first component or layer)} \]

It will be evident to persons skilled in the art that the difference in refractive index may be a positive or negative number.

[0031] The term "%haze", as used herein, refers to haze values determined according to ASTM Method D1 003 using a HunterLab UltraScan Sphere 8000 Colorimeter manufactured by Hunter Associates Laboratory, Inc., Reston, Va using Hunter’s Universal Software (version 3.8) (%Haze = 100 * Diffuse Transmission / Total Transmission). The procedure for the determination of refractive index is provided in the Examples. For the compositions of the invention, haze and % transmittance is determined by molding or casting the composition into a sheet or film having a thickness of 1/8 inch or less and measuring the haze according to the procedure described in the examples. For shaped articles, including multilayer shaped articles, the haze and % transmittance can be determined by cutting out a small (i.e., 1 X 1 cm) section of the article, having a thickness of 1/8 inch or less, and measuring the haze according to the procedure described herein.

[0032] The term glass transition temperature ("Tg") as used herein, refers to the Tg values determined using differential scanning calorimetry ("DSC"), typically using a scan rate of 20°C/min. An example of a DSC instrument is TA Instruments 2920 Differential Scanning Calorimeter.

[0033] The compositions of the present invention comprise a first component comprising one or more thermoplastic polymers selected from polyesters, polycarbonates, polyarylates, and homogeneous blends thereof. The term "thermoplastic polymer", as used herein, is intended to have its plain meaning as would be understood by persons having ordinary skill in the art, that is, a polymer that softens when exposed to heat and returns to its original condition when cooled to room temperature. The first component may comprise a single thermoplastic polymer or may comprise a blend of 2 or more polymers provided that the blend is a homogeneous blend. The term "homogeneous, blend", as used herein, is synonymous with the term "miscible", and is intended to mean that the blend has a single, homogeneous phase as indicated by a single, composition-dependent Tg. For example, a first polymer that is miscible with second polymer may be used to "plasticize" the second polymer as illustrated, for example, in U.S. Patent No. 6,211,309. Homogeneous blends may be formed by simply blending two or polymers or, in the case of condensation polymers such as for example, polyesters or polyamides, by transesterifying or transamidating two or more polymers. By contrast, the term "immiscible", as used herein, denotes a blend that shows at least 2, randomly mixed, phases and exhibits more than one Tg. Some polymers may be immiscible and yet compatible with each other. A further general description of miscible and immiscible polymer blends and the various analytical techniques for their characterization may be found in Polymer Blends Volumes 1 and 2. Edited by D.R. Paul and C.B. Bucknall, 2000, John Wiley & Sons, Inc.

[0034] The first component may comprise one or more thermoplastic polymers selected from polyesters, polycarbonates, polyarylates, and homogeneous blends thereof. For example, the first component may comprise a polyester
comprising (a) diacid residues, comprising at least 80 mole percent, based on the total diacid residues, of the residues of at least one dicarboxylic acid selected from terephthalic acid, isophthalic acid, naphthalenedicarboxylic acid, and 1,4-cyclohexanedicarboxylic acid, and 0 to about 20 mole percent of the residues of at least one modifying dicarboxylic acid having 2 to 20 carbon atoms; and (b) diol residues comprising at least 80 mole percent, based on the total moles of diol residues, of the residues of at least one diol selected from ethylene glycol, 1,4-cyclohexanedi methanol; neopentyl glycol, diethylene glycol, 1,3-propanediol, 1,4-butanediol, and, 2,2,4,4-tetramethyl-1,3-cyclobutanediol; and from 0 to about 20 mole percent of the residues of at least one modifying diol having from 3 to 16 carbons. Cyclic diols containing cis and trans isomers may be used as the pure cis or trans isomer or as a mixture of cis and trans isomers.

[0035] For example, the diacid residues can comprise the residues of one or more dicarboxylic acids selected from terephthalic acid, isophthalic acid, or combinations thereof, and the diol residues comprise the residues of one or more diols selected from 1,4-cyclohexanedi methanol, neopentyl glycol, ethylene glycol, and combinations thereof. In one embodiment, for example, the diacid residues may comprise the residues of terephthalic acid and isophthalic acid. A higher concentration of terephthalic acid in the polyester than isophthalic acid is advantageous because the resulting polyester provides greater impact strength to the blend. For example, the diacid residues may comprise from about 60 to about 100 mole percent of the residues terephthalic acid and 0 to about 40 mole percent of the residues isophthalic acid and the diol residues may comprise about 100 mole percent of the residues of the 1,4-cyclohexanedi methanol. Other examples of dicarboxylic acid content include about 80 to about 100 mole percent terephthalic acid and 0 to 20 mole percent isophthalic acid, and about 100 mole percent terephthalic acid.

[0036] Other representative polyesters that may be used as the thermoplastic polymers of component (i) include polyesters comprising: (a) diacid residues comprising 80 to 100 mole percent of the residues of terephthalic acid and diol residues comprising about 50 to about 90 mole percent of the residues of 1,4-cyclohexanedi methanol and about 10 to about 50 mole percent of the residues of neopentyl glycol; (b) diacid residues comprising 100 mole percent of the residues of terephthalic acid and diol residues comprising about 10 to about 40 mole percent of the residues of 1,4-cyclohexanedi methanol and 60 to about 90 mole percent of the residues of ethylene glycol; (c) diacid residues comprising 100 mole percent terephthalic acid and diol residues comprising about 10 to about 99 mole percent of the residues of the 1,4-cyclohexanedi methanol, 0 to about 90 mole percent of the residues of ethylene glycol, and about 1 to about 25 mole percent of the residues of the diethylene glycol; and (d) diacid residues comprising 100 mole percent terephthalic acid and diol residues comprising about 50 to about 90 mole percent 1,4-cyclohexanedi methanol and about 10 to about 50 mole percent ethylene glycol.

[0037] In yet another example, the dicarboxylic acid may be selected from terephthalic acid and isophthalic acid, and the diol is selected from 1,4-cyclohexanedi methanol and ethylene glycol. In one composition, for example, the dicarboxylic acid is terephthalic acid and the diol is 1,4-cyclohexanedi methanol. In yet another example, the diacid residues may comprise at least 95 mole percent of the residues of terephthalic acid and the diol residues may comprise about 10 to about 40 mole percent of the residues of the 1,4-cyclohexanedi methanol, about 1 to about 25 mole percent of the residues of the diethylene glycol, and about 35 to about 89 mole percent of the residues of ethylene glycol.

[0038] The polyester may further comprise 0 to about 20 mole percent of one or more residues of a modifying diacid containing 2 to 20 carbon atoms if desired. For example, from 0 to about 30 mole % of other aromatic dicarboxylic acids containing 8 to about 16 carbon atoms, cyclic alicyclic dicarboxylic acids containing 8 to about 16 carbon atoms, aliphatic dicarboxylic acids containing about 2 to about 16 carbon atoms, or mixtures thereof may be used. Examples of modifying dicarboxylic acids include, but are not limited to, one or more of 4,4'-biphenyldicarboxylic acid, 1,4-naphthalenedicarboxylic acid, 1,5-naphthalenedicarboxylic acid, 2,6-naphthalenedicarboxylic acid, 2,7-naphthalenedicarboxylic acid, 4,4'-oxybenzoic acid, trans-4,4'-stilbene dicarboxylic acid, oxalic acid, malonic acid, succinic acid, glutaric acid, adipic acid, pimelic acid, suberic acid, azelaic acid, and sebacic acid.

[0039] In another embodiment, the polyester can comprise about 1 to about 99 mole percent, based on the total moles of diol residues, of the residues of 1,4-cyclohexanedi methanol, about 99 to about 1 mole percent of the residues ethylene glycol. Typical mole percentages for the residues of 1,4-cyclohexanedi methanol for the polyesters of the invention include from about 1 to about 10 mole percent, from about 1 to about 25 mole percent, from about 1 to about 40 mole percent, 50 mole percent and greater, and 100 mole percent. In another embodiment, for example, the dicarboxylic acid is 1,4-cyclohexanedicarboxylic acid and the diol is 1,4-cyclohexanedi methanol. In a further example, the polyester may comprise the residues of 1,4-cyclohexanedi methanol units and the neopentyl glycol. In yet another example, the polyester may comprise the residues of 1,4-cyclohexanedi methanol units and 2,2,4,4-tetramethyl-1,3-cyclobutanediol:

[0040] The diol component of the polyester also may be modified from 0 to about 20 mole percent of the residues of at least one modifying diol having from 3 to 16 carbons. Other ranges of modifying diol include, but are not limited to, from 0 to about 10 mole percent, and less than 5 mole percent. The modifying diol may be selected from one or more of 1,2-propanediol, 1,3-propanediol, 1,4-butanediol, 1,5-pentanediol, 1,6-hexanediol, 1,4-cyclohexanedi methanol, p-xylene glycol, neopentyl glycol, polyethylene glycol, polytetramethylene glycol, and 2,2,4,4-tetramethyl-1,3-cyclobutanediol. Examples of polyalkylene glycols include poly(tetramethylene glycol) ("PTMG") and poly(ethylene glycol) ("PEG") having molecular weights up to about 2,000. The diol component, for example, can be modified with 0 to about 10 mole
percent polyethylene glycol or polytetramethylene glycol to enhance elastomeric behavior. In another example, the diol residues may comprise about 10 to about 99 mole percent of residues of 1,4-cyclohexanediol, 0 to about 90 mole percent of residues of ethylene glycol, and about 1 to about 25 mole percent of residues of diethylene glycol. The polyester also may contain up to about 5 mole percent, typically from about 0.1 to about 2.0 mole%, based on the acid or diol component, of the residues of a polyfunctional branching agent derived from a compound having at least three carboxyl and/or hydroxy groups to form a branched polyester. Examples of such compounds include trimellitic acid or anhydride, trimesic acid, pyromellitic anhydride, trimethylolane, trimethylolpropane, a trimer acid, and the like. It will be understood by persons skilled in the art that the final composition can be arrived at by blending various resins or by direct reactor copolymerization. The latter is desirable to minimize compositional variability but economic necessities often make blending more cost effective.

[0041] Additional examples of polyesters are those containing 100 mole percent terephthalic residues, based on the total diacid residues, and any one of the following diol residue compositions, based on the total diol residues: (i) about 1 to about 5 mole percent of the residues of 1,4-cyclohexanediol; (ii) about 29 to about 33 mole percent of the residues of 1,4-cyclohexanediol and about 71 to about 67 mole percent of the residues of ethylene glycol; (iii) about 45 to about 55 mole percent of the residues of 1,4-cyclohexanediol and about 55 to about 45 mole percent of the residues of ethylene glycol; (iv) about 60 to about 65 mole percent of the residues of 1,4-cyclohexanediol and about 40 to about 35 mole percent of the residues of ethylene glycol; (v) about 79 to about 83 mole percent of the residues of 1,4-cyclohexanediol and about 21 to about 17 mole percent of the residues of ethylene glycol; and (vi) about 100 mole percent of the residues of 1,4-cyclohexanediol.

[0042] The polyesters generally will have inherent viscosity (I.V.) values in the range of about 0.4 dL/g to about 1.4 dL/g. Additional examples of I.V. ranges include about 0.65 dL/g to about 1.0 dL/g and about 0.7 dL/g to about 0.85 dL/g. As described previously, inherent viscosity is measured at 25 °C using 0.5 grams of polymer per 100 ml of a solvent comprising 60 weight percent phenol and 40 weight % tetrachloroethane.

[0043] The polymers of the invention may be crystalline, semicrystalline, or amorphous polymers. The term "semicrystalline", as used herein, means that the polymer contains two phases: an ordered crystalline phase and an unordered amorphous phase. Polymers with a semicrystalline morphology exhibit both a crystalline melting temperature (Tm) and a glass transition temperature (Tg) and may be distinguished from "amorphous" polymers, which exhibit only a glass transition temperature.

[0044] The polyesters used in the present invention typically are prepared from dicarboxylic acids and diols which react in substantially equal proportions and are incorporated into the polyester polymer as their corresponding residues. The polyesters derived from dicarboxylic acid and diol residues of the present invention, therefore, contain substantially equal molar proportions of acid residues (100 mole percent) and diol residues (100 mole percent) such that the total moles of repeating units is equal to 100 mole percent. The mole percentages provided in the present disclosure, therefore, may be based on the total moles of acid residues, the total moles of diol residues, or the total moles of repeating units. For example, a copolyester containing 30 mole percent terephthalic acid, based on the total acid residues, means that the copolyester contains 30 mole percent terephthalic residues out of a total of 100 mole percent acid residues. Thus, there are 30 moles of terephthalic residues among every 100 moles of acid residues. In another example, a copolyester containing 30 mole percent 1,4-cyclohexanediol, based on the total diol residues, means that the copolyester contains 30 mole percent 1,4-cyclohexanediol residues out of a total of 100 mole percent diol residues. Thus, there are 30 moles of 1,4-cyclohexanedimethanol residues among every 100 moles of diol residues. As used herein, copolyesters of terephthalic acid, ethylene glycol, and 1,4-cyclohexanediol may be referred to as "PET" when the glycol component is primarily ethylene glycol, "PCT" when the glycol component is primarily 1,4-cyclohexanediol, "PETG" when the ratio of ethylene glycol to 1,4-cyclohexanediol is greater than 1 and "PCTG" when the ratio of ethylene glycol to 1,4-cyclohexanediol ratio is less than 1.

[0045] The polyesters of the instant invention are readily prepared from the appropriate dicarboxylic acids, esters, anhydrides, or salts, and the appropriate diol or diol mixtures using typical polycondensation reaction conditions. Thus, the dicarboxylic acid component of the polyesters of the present invention can be derived from dicarboxylic acids, their corresponding esters, or mixtures thereof. Examples of esters of the dicarboxylic acids useful in the present invention include the dimethyl, dipropyl, disopropyl, dibutyl, and diphenyl esters, and the like.

[0046] The polyesters of the present invention are prepared by procedures known to persons skilled in the art. They may be made by continuous, semi-continuous, and batch modes of operation and may utilize a variety of reactor types. Examples of suitable reactor types include, but are not limited to, stirred tank, continuous stirred tank, slurry, tubular, wiped-film, falling film, or extrusion reactors. The reaction of the diol and dicarboxylic acid may be carried out using conventional polyester polymerization conditions or by melt phase processes, but those with sufficient crystallinity may be made by melt phase followed by solid phase polycondensation techniques. For example, when preparing the polyester by means of an ester interchange reaction, i.e., from the ester form of the dicarboxylic acid components, the reaction process may comprise two steps. In the first step, the diol component and the dicarboxylic acid component, such as,
for example, dimethyl terephthalate, are reacted at elevated temperatures, typically, about 150°C to about 250°C for about 0.5 to about 8 hours at pressures ranging from about 0.0 kPa gauge to about 414 kPa gauge (60 pounds per square inch, "psig"). Preferably, the temperature for the ester interchange reaction ranges from about 180°C to about 230°C for about 1 to about 4 hours while the preferred pressure ranges from about 103 kPa gauge (15 psig) to about 276 kPa gauge (40 psig). Thereafter, the reaction product is heated under higher temperatures and under reduced pressure to form the polyester with the elimination of diol, which is readily volatilized under these conditions and removed from the system. This second step, or polycondensation step, is continued under higher vacuum and a temperature which generally ranges from about 230°C to about 350°C, preferably about 250°C to about 310°C and, most preferably, about 260°C to about 290°C for about 0.1 to about 6 hours, or preferably, for about 0.2 to about 2 hours, until a polymer having the desired degree of polymerization, as determined by inherent viscosity, is obtained. The polycondensation step may be conducted under reduced pressure which ranges from about 53 kPa (400 torr) to about 0.013 kPa (0.1 torr). Stirring or appropriate conditions are used in both stages to ensure adequate heat transfer and surface renewal of the reaction mixture. The reaction rates of both stages are increased by appropriate catalysts such as, for example, alkoxy titanium compounds, alkali metal hydroxides and alcoholates, salts of organic carboxylic acids, alkyl tin compounds, metal oxides, and the like. A three-stage manufacturing procedure, similar to that described in U.S. Patent No. 5,290,631, may also be used, particularly when a mixed monomer feed of acids and esters is employed.

To ensure that the reaction of the diol component and dicarboxylic acid component by an ester interchange reaction is driven to completion, it is sometimes desirable to employ about 1.05 to about 2.5 moles of diol component to one mole dicarboxylic acid component. Persons of skill in the art will understand, however, that the ratio of diol component to dicarboxylic acid component is generally determined by the design of the reactor in which the reaction process occurs.

In the preparation of polyester by direct esterification, i.e., from the acid form of the dicarboxylic acid component, polyesters are produced by reacting the dicarboxylic acid or a mixture of dicarboxylic acids with the diol component or a mixture of diol components. The reaction is conducted at a pressure of about from 7 kPa gauge (1 psig) to about 1379 kPa gauge (200 psig), preferably less than 689 kPa (100 psig) to produce a low molecular weight polyester product having an average degree of polymerization of from about 1.4 to about 10. The temperatures employed during the direct esterification reaction typically range from about 180°C to about 280°C, more preferably ranging from about 220°C to about 270°C. This low molecular weight polymer may then be polymerized by a polycondensation reaction.

The thermoplastic polymers of the invention may also comprise a polylactate. Polylactates are obtained by polymerization of a dihydric phenol and a dicarboxylic acid. Examples of polylactates that can be used in the compositions, processes, and shaped articles of the instant invention are described in U.S. Patent No.'s 4,598,130; 5,034,502; and 4,374,239. Examples of dihydric phenols that can be used to prepare the polylactates are bisphenols such as bis(4-hydroxyphenyl)methane; 2,2-bis(4-hydroxyphenyl)propane ("bisphenol-A"); 2,2-bis(4-hydroxy-3-methylphenyl)propane; 4,4-bis(4-hydroxyphenyl)heptane; 2,2-bis(4-hydroxy-3,5-dichlorophenyl)propane; 2,2-bis(4-hydroxy-3,5-dibromophenyl)propane; dihydric phenol ethers such as, for example, bis(4-hydroxyphenyl)ether; bis(3,5-dichloro-4-hydroxyphenyl)ether; dihydroxydiphenyls such as, for example, p,p'-dihydroxydiphenyl; 3,3'-dichloro-4,4'-dihydroxydiphenyl; dihydroxyaryl sulfones such as, for example, bis(4-hydroxyphenyl)sulfone; bis(3,5-dimethyl-4-hydroxyphenyl)sulfone; dihydroxybenzenes such as, for example, resorcinol; hydroquinone; halogenated dihydroxybenzenes such as, for example, 1,4-dihydroxy-2,5-dichlorobenzene; 1,4-dihydroxy-3-methylbenzene; and dihydroxy diphenyl sulfides such as, for example, bis(4-hydroxyphenyl)sulfide; and bis(3,5-dibromo-4-hydroxyphenyl) sulfide. A variety of additional dihydric phenols are also available such as are disclosed, for example, in U.S. Pat. Nos. 2,999,835; 3,028,365 and 3,153,008. Also suitable are copolymers prepared from the above dihydric phenols copolymerized with halogen-containing dihydric phenols such as 2,2-bis(3,5-dichloro-4-hydroxyphenyl)propane and 2,2-bis(3,5-dibromo-4-hydroxyphenyl)propane. It is also possible to employ two or more different dihydric phenols or a copolymer of a dihydric phenol with a glycol, with hydroxy or acid terminated polyester, or with a dibasic acid as well as blends of any of the above materials. Suitable dicarboxylic acids include, but are not limited to, aromatic dicarboxylic acids such as phthalic, isophthalic, terephthalic, pthalic, o-, m-, and p-phenylenedioic acids, and polynuclear aromatic acids such as, for example, diphenic acid and 1,4-naphthoic acid.

Additional examples of polylactates that can be used in the present invention. Include those polymers resulting from the polymerization of bisphenol A (2,2-bis-(4-hydroxyphenyl)propane) and a 50:50 mixture iso/terephthalic acids. Some of the polymers are commercially available under the trademark "U- Polymer U-100" (available from Unitika America Corporation). Other examples are polylactates based on tetramethyl bisphenol-A; 4,4'-dihydroxybenzophenone; and 5-tertiary-butyl isophthalic acid dichloride.

The polylactates of the present Invention can be prepared by any polyester forming reactions well known in the art such as, for example, interfacial polymerization by mixing a solution of an aromatic dicarboxylic acid dihalide in an organic solvent with an alkaline aqueous solution of a bisphenol under stirring to react these materials; solution polymerization by reacting an aromatic dicarboxylic acid dihalide with a bisphenol in the presence of a deacidifying agent such as pyridine in an organic solvent; molten polymerization by reacting an aromatic dicarboxylic acid diphenyl ester
with a bisphenol; molten polymerization by reacting an aromatic dicarboxylic acid, diphenyl carbonate and a bisphenol; molten polymerization by reacting an aromatic dicarboxylic acid with a bisphenol diacetate; and polymerization by reacting an aromatic dicarboxylic acid with a bisphenol diacetate. Examples of methods for preparation of polyarylates are disclosed in U.S. Patent No.'s 5,034,502, 4,321,355, and 4,374,239. The polyarylates of the invention typically have inherent viscosities of about 0.5 to about 1.1 dL/gm.

[0052] In addition, the polyester, polycarbonates, and polyarylates may further comprise one or more of the following: antioxidants, melt strength enhancers, branching agents (e.g., glycerol, trimellitic acid and anhydride), chain extenders, flame retardants, fillers, acid scavengers, dyes, colorants, pigments, antiblocking agents, flow enhancers, impact modifiers, antistatic agents, processing aids, mold release additives, plasticizers, slips, stabilizers, waxes, UV absorbers, optical brighteners, lubricants, pinning additives, foaming agents, antistats, nucleators, and the like. Colorants, sometimes referred to as toners, may be added to impart a desired neutral hue and/or brightness to the polyester. Preferably, the polyester compositions may comprise 0 to about 30 weight percent of one or more processing aids to alter the surface properties of the composition and/or to enhance flow. Representative examples of processing aids include calcium carbonate, talc, clay, mica, zeolites, wollastonite, kaolin, diatomaceous earth, TiO₂, NH₄Cl, silica, calcium oxide, sodium sulfate, and calcium phosphate. Use of titanium dioxide and other pigments or dyes, might be included, for example, to control whiteness of the film, or to make a colored articles. An antistat or other coating may also be applied to the surface of the article.

[0053] The second component (ii) of the compositions of the invention comprises a transamidized, homogeneous blend of at least two polyamides. Typically, the homogeneous blend will comprise from 2 to about 10 different polyamides. In another example, the homogeneous blend can comprise from 2 to 4 polyamides. In accordance with the present invention, polyamides that display a melting point below about 300°C can be used as at least one polyamide. In another examples, polyamides with the melting point less than about 275°C and glass transition temperature greater than about 25°C may be used. Typically, the polyamides have an I.V. between about 0.3 dL/g and about 2.0 dL/g and, preferably at least 0.5 dL/g.

[0054] For the composition of the invention, it is advantageous that transamidation occur between the polyamides to produce of homogeneous blend. The term "transamidized", as used herein, is intended to be synonymous with the terms "transamidate" and "transamidation", and means the process of exchanging amido groups between two different polyamides. Transamidation between two or more polyamides can be accomplished by contacting the polyamides at elevated temperatures, typically from about 270°C to about 350°C. Other examples of transamidation temperatures are about 280°C to about 350°C and about 290°C to about 340°C. Transamidation between the polyamides is indicated by the presence of a single glass transition temperature ("Tg") for the blend as determined by differential scanning calorimetry ("DSC") using standard techniques well known to persons skilled in the art such as, for example, described in ASTM Method D3418. The polyamides may be heated together directly at these temperature or in the presence of the thermoplastic polymers of the first component (i). For example, the contacting and, hence, transamidation of the polyamides can take place by melt blending of the first and second components, during extrusion, or other high temperature processing of the polymer composition and its components. In another example, the polyamides may be heated together in a separate vessel and then melt blended with the first component.

[0055] The first and second polyamides of the second component may be selected from a wide range of polyamides. To better match the refractive index of the first component, it is desirable, but not essential, that at least one of the polyamides comprise aromatic residues. In one example, the polyamides can comprise partially aromatic polyamides and aliphatic polyamides having a number average molecular weight of 7,000 or less. Combinations of such polyamides are included also within the scope of the invention. Partially aromatic polyamides comprise amide linkages between at least one aromatic ring and at least one nonaromatic species. Although wholly aromatic polyamides generally are liquid crystalline, the blends of such resins having melting points less than 300°C can be used for this invention. When homogeneous blends of polyamides are used, the rapid transamidization (amide-amide interchange) of aliphatic nylon with aromatic or partially aromatic polyamide permits the tailoring of refractive index of the polyamide blend by adjusting the ratios of aliphatic polyamide to aromatic, or partially aromatic, polyamide. This technique enables a matching of the refractive index of the homogeneous polyamide blend to the thermoplastic polymer such as, for example, one or more polyester, of the first component. A reference for transamidization can be found in the work by Y. Takeda, et.al., Polymer, 1992 vol. 33, pg. 3394.

[0056] In accordance with the invention, the second component can be a transamidized, homogeneous blend of 2 or more polyamides such as, for example, a first polyamide and a second polyamide which are selected to give a refractive index in the second component such that second and first components have a difference in refractive index (RI(second component) - RI(first component)) of about 0.006 to about -0.0006. To match the refractive index of the first component, it is advantageous that the first and second polyamide have different amounts of aromatic and aliphatic residues. For example, the second component (ii) can comprise a homogeneous blend of a first polyamide, comprising aromatic residues, and of a second polyamide comprising aliphatic residues. The term "aliphatic", as used herein with respect to the diamine and dicarboxylic acid monomers of the polyamides of the present invention, means that carboxyl or amino...
groups of the monomer are not connected through an aromatic nucleus. For example, adipic acid contains no aromatic nucleus in its backbone, i.e., the chain of carbon atoms connecting the carboxylic acid groups; thus, it is "aliphatic". By contrast, the term "aromatic" means the dicarboxylic acid or diamine contains an aromatic nucleus In the backbone such as, for example, terephthalic acid or 1,4-metaxylylene diamine. Representative examples of aromatic polyamides are those polyamids comprising at least 70 mole % of residues comprising diamines such as m-xylénylenediamine or a xylénylenediamine mixture comprising m-xylénylenediamine and up to 30% of p-xylénylenediamine and an aliphatic dicarboxylic acid having 6 to 10 carbon atoms. The term "aliphatic", therefore, is intended to include both aliphatic and cycloaliphatic structures such as, for example, diamide, diacid, lactams, aminoalcohols and aminoarboxylic acids, that contain as a backbone a straight or branched chain or cyclic arrangement of the constituent carbon atoms which may be saturated or paraffinic in nature, unsaturated (i.e., containing non-aromatic carbon-carbon double bonds), or acetylenic (i.e., containing carbon-carbon triple bonds). Thus, in the context of the description and the claims of the present invention, aliphatic is intended to include linear and branched, chain structures (referred to herein as "aliphatic") and cyclic structures (referred to herein as "cycloaliphatic") in their mono- and polymeric forms.

(0057) The weight percentage ratio of the first and second polyamides present in the transamidized, homogeneous blend may range from about 1:50 to about 50:1 based on the total weight of the second component. Other examples of weight percentage ratios are 1:20 to about 20:1 and about 1:10 to about 10:1.

(0058) Examples of polyamides that may be used in the homogeneous blends of the present invention include polyamides comprising one or more of residues selected from isophthalic acid, terephthalic acid, cyclohexanedicarboxylic acid, meta-xylénylenediamine (also referred to herein as "m-xylénylenediamine"), para-xylénylenediamine (also referred to herein as "p-xylénylenediamine"), 1,3-cyclohexane(bis)methylamine, 1,4-cyclohexane(bis)methylamine, aliphatic diacids with 6 to 12 carbon atoms, aliphatic amino acids or lactams with 6 to 12 carbon atoms, aliphatic diamines with 4 to 12 carbon atoms. Generally, any polyamide forming diacids and diamines can be used. The polyamides also may contain small amounts of trifunctional or tetrafunctional comonomers such as trimellitic anhydride, pyromellitic dianhydride, or other polyyamide forming polyacids and polylamines known in the art.

(0059) Examples of partially aromatic polyamides include, but are not limited to: poly(m-xylénylene adipamide) (referred to herein as "MXD6" nylon), poly(hexamethylene isophthalalamide), poly(hexamethylene adipamide-co-isophthalalamide), poly(hexamethylene adipamide-co-terephthalamide), and poly(hexamethylene isophthalalamide-co-terephthalamide). In one embodiment, the partially aromatic polyamide is poly(m-xylénylene adipamide). In one embodiment, the partially aromatic polyamides may have a number average molecular weight of 7000 or less. Representative examples of aliphatic polyamides include poly(2-pyrrolidinone) (nylon 4, 6; CAS No. 44,299-2), poly(acrylamide) (nylon 6; CAS No. 18,111-0), poly(2-piperidone) (nylon 5; CAS No. 24938-57-6), poly(7-aminohexanoic acid) (nylon 7; CAS No. 25035-01-2), poly(nonanamide) (nylon 9; CAS No. 25748-72-5), poly(11-aminoundecanoic acid) (nylon 11; CAS No. 25035-04-5), poly(12-aminolauryl acid) (nylon 12, CAS No. 24937-16-4), poly(ethyleneadipamide) (nylon 2,6; CAS No. 50327-22-5), poly(hexamethylene adipamide) (nylon 6,8; CAS No. 42,917-1), poly(hexamethylene-sebacamide) (nylon 6,10; CAS No. 9008-66-6), poly(hexamethylene-undecanamide) (nylon 6,11) poly(hexamethylene-dodecamide) (nylon 6,12; CAS No. 24936-71-4), poly(octamethylene-adipamide) (nylon 8,6); adipic acid-decamethylene adipamide copolymer (nylon 10,6; CAS No. 26123-27-3); poly(decamethylene-dodecamide) (nylon 10,12); poly(dodecamethylene adipamide) (nylon 12,8); and poly(undecamethylene-sebacamide) (nylon 12,8).

(0060) For example, the second component (ii) can comprise a homogeneous blend comprising a first polyamide comprising the residues of m-xylénylenediamine and adipic acid, and a second polyamide comprising the residues of at least one aliphatic or cycloaliphatic monomer selected from adipic acid, pimelic acid, suberic acid, azelaic acid, sebacic acid, undecanedioc acid, dodecanedioc acid, caprolactam, butyrolactam, 11-amionoundecanedioc acid, isophthalic acid, and hexamethylene diamine. The first polyamide, for example, may comprise MXD6 nylon, which is commercially available from Mitsubishi Corporation. In another example, the second polyamide may comprise at least one polyamide selected from from nylon 4; nylon 6; nylon 9; nylon 11; nylon 12; nylon 6,6; nylon 5,10; nylon 6,12; nylon 6,11; nylon 10,12; and combinations thereof. In yet another example, the second polyamide may comprise nylon 6, nylon 6,6, or blends thereof.

(0061) The second component also may comprise a single copolyamide in which the composition of monomer residues is chosen to give a refractive index that closely matches the refractive index of the first component. Thus, in another embodiment, the invention provides a polymer composition, comprising an immiscible blend of:

(i) a first component comprising at least one thermoplastic polymer selected from polyesters, polycarbonates, polylonates, and homogeneous blends thereof; and

(ii) a second component comprising a copolyamide;

wherein the second component (ii) and the first component (i) have a difference in refractive index, RI(second component) - RI(first component), of about 0.006 to about -0.0006, and the immiscible blend has a percent transmittance of at least
such as, for example, caprolactam, or lactams, based on gamma-
or about 10 mole percent to about 70 mole percent, based on the total moles of repeating units.

Based on gamma-
or about 25 to about 80 mole percent. The remaining residues can comprise from one or more aliphatic or aromatic dicarboxylic acids having from 7-12 carbon atoms, such as pimelic acid, suberic acid, azelaic acid, sebacic acid, undecanedioic acid, dodecanedioic acid, and 1,4-cyclohexanedicarboxylic acid, based on a total diacid residue content of 100 mole%. It is understood that the various embodiments of homogeneous blends of polyamides and copolyamides referred to herein can be combined with any of the embodiments of the polyesters discussed hereinabove.

[0062] Other examples of copolyamides that can be used as in composition of the invention, either alone or as part of a homogeneous blend with another polyamide, include, but are not limited to, copolyamides comprising from about 15 to about 100 mole percent of the residues of m-xylylenediamine, based on a total diamine residue content of 100 mole%, and the residues of adipic acid. Typical amounts of adipic acid residues which may be present in these copolyamides, based on the total moles of diacid residues, are about 5 to about 85 mole percent, about 20 to about 80 mole percent, and about 25 to about 75 mole percent. The remainder of the diacid residues can comprise residues from one or more aliphatic dicarboxylic acids having from 7-12 carbon atoms, such as pimelic acid, suberic acid, azelaic acid, sebacic acid, undecanedioic acid, dodecanedioic acid, or 1,4-cyclohexanedicarboxylic acid. In another example, the polyamide acid also may comprise residues from isophthalic acid and terephthalic acid.

[0063] The copolyamides of the invention also may comprise other diamines or lactam residues in addition to m-xylylenediamine residues. For example, the copolyamide can comprise at least 15 mole percent, or at least about 20 mole percent of the residues of m-xylylenediamine with the remainder of the diamines residues comprising the residues of one or more aliphatic or aromatic diamines. For example, the copolyamide may comprise about 80 mole percent or about 85 mole %, of the residues of 1,6-hexamethylene diamine, based on the total moles of diamine residues. Varying amounts of p-xylylenediamine, 1,3-cyclohexanedis(methylamine), or 1,4-cyclohexanedis(methylamine), also may be used. Similarly, the copolyamide may comprise the residues of a lactam, such as caprolactam, or lactams based on gamma-amino-butyrlic acid or 11-amino-undecanoic acid, in an amount from about 10 mole percent to about 90 mole percent, or from about 10 mole percent to about 70 mole percent based on the total moles of repeating units. In another embodiment, the copolyamides of the invention can comprise from about 15 mole percent to about 85 mole percent, about 20 to about 80 mole percent, or about 25 to about 75 mole percent of the residues from m-xylylenediamine, based on the total moles of diamine residues with the remainder of the diamine residues comprising residues from one or more diamines, such as aliphatic diamines, and especially 1,6-hexamethylenediamine. In this embodiment, the diamine residues may further comprise minor amounts of the residues of other diamines, for example p-xylylenediamine, or a cyclic aliphatic diamine such as, for example, one or more of: 1,3-cyclohexanedis(methylamine) or 1,4-cyclohexanedis(methylamine). Further, the polyamide may optionally include, in place of a portion of the adipic acid, residues from one or more aliphatic or aromatic dicarboxylic acids having from 7-12 carbon atoms, such as pimelic acid, suberic acid, azelaic acid, sebacic acid, undecanedioic acid, dodecanedioic acid, 1,4-cyclohexanedicarboxylic acid, or isophthalic acid, which may be present in an amount from about 15 mole percent to about 85 mole percent, optionally with minor amounts of terephthalic acid. The polyamide also may comprise the residues of a lactam, such as caprolactam, or lactams based on gamma-amino-butyrlic acid or 11-amino-undecanoic acid, in an amount from about 10 mole percent to about 90 mole percent, or about 10 mole% to 70 mole percent, based on the total moles repeating units.

[0064] In yet another embodiment, the copolyamides according to the invention may comprise from about 15 mole percent up to about 90 mole percent of residues from adipic acid, with the remaining diacid residues comprising the about 10 to about 85 mole percent of the residues of isophthalic acid, based on the total moles of dicarboxylic acid residues. Additional examples of adipic acid and isophthalic acid residue content include about 20 to 80 mole percent, and about 25 to about 75 mole percent. In this embodiment, the polyamide may optionally comprise minor amounts of residues from one or more aliphatic dicarboxylic acids having from 7-12 carbon atoms, such as pimelic acid, suberic acid, azelaic acid, sebacic acid, undecanedioic acid, dodecanedioic acid, or 1,4-cyclohexanedicarboxylic acid, optionally with minor amounts of terephthalic acid. Optionally, the polyamides may comprise m-xylylenediamine residues. Examples of m-xylylenediamine residue concentrations include about 15 to about 90 mole percent, about 20 to about 85 mole percent, or about 25 to about 80 mole percent. The remaining residues can comprise from one or more aliphatic diacids, such as, for example, 1,6-hexamethylenediamine, one or more aromatic diamines such as, for example, p-xylylenediamine. Similarly, the copolyamide also may comprise the residues of a lactam such as, for example, caprolactam, or lactams based on gamma-amino-butyrlic acid or 11-amino-undecanoic acid, in an amount from about 10 mole percent to about 90 mole percent or about 10 mole percent to about 70 mole percent, based on the total moles of repeating units.

[0065] In yet another example, the copolyamides of the invention may comprise the residues of one or more lactams such as, for example, caprolactam, or lactams, based on gamma-amino-butyrlic acid or 11-amino-undecanoic acid, in
an amount from about 10 mole percent to about 90 mole percent, or from about 10 mole percent to about 70 mole percent, or from about 15 mole percent to about 60 mole percent, based on the total moles of repeating units. The residues of one or more aliphatic dicarboxylic acids having from 7-12 carbon atoms, such as pimelic acid, suberic acid, azelaic acid, sebacic acid, undecanedioic acid, dodecanedioic acid, or 1,4-cyclohexanedicarboxylic acid, also may be present in amounts from about 20 mole percent to about 80 mole percent, based on the total moles of repeating units. For example, the copolyamide may comprise residues from isophthalic acid or terephthalic acid. In this embodiment, the copolyamides can comprise from about 15 mole percent to about 85 mole percent of the residues from m-xylylenediamine, based on the total moles of diamine residues. Other examples of m-xylylenediamine content are about 20 to about 80 mole percent and about 25 to about 75 mole percent. The remainder of the diamine residues may comprise the residues of one or more diamines aliphatic diamines such as, for example, 1,6-hexamethylene diamine. In this embodiment, the diamine residues may further comprise minor amounts of the residues of other diamines, for example p-xylylenediamine, or a cyclic aliphatic diamine such as, for example, one or more of: 1,3-cyclohexanedis(methylamine) or 1,4-cyclohexanedis(methylamine). Optionally, minor amounts of one or more of: p-xylylenediamine, 1,3-cyclohexanedis(methylamine), or 1,4-cyclohexanedis(methylamine), may be used.

Another embodiment of the invention is polymer composition, consisting essentially of an immiscible blend of:

(i) a first component consisting essentially of at least one thermoplastic polymer selected from polyesters, polycarbonates, polycarbonates, and homogeneous blends thereof; and

(ii) a second component consisting essentially of a homogeneous, transamidized blend of at least 2 polyamides;

wherein the second component (ii) and the first component (i) have a difference in refractive index, RI(second component) - RI(first component), of about 0.006 to about -0.0006, and the immiscible blend has a percent transmittance of at least 75%, and a haze of 10% or less. The phrase "consisting essentially of", as used herein is intended to encompass compositions which are immiscible blends, that is, having at least 2, composition-dependent Tg’s as measured by DSC, and which have first component containing a polyester, polycarbonate, polyarylate, or homogeneous blends thereof and a second component containing a homogeneous, transamidized blend of at least 2 polyamides. In this embodiment, the composition is understood to exclude any elements that would substantially alter the essential properties of the composition to which the phrase refers. For example, compositions may include other components that do not alter the refractive index of the components, %haze of the blend, the %transmittance, or the miscibility of the blend. For example, the addition an oxygen-scavenging component other than a copolyamide or a transamidized blend of polyamides would be excluded from this embodiment. Similarly, a second component containing a copolyamide prepared by copolymerization of the component monomers would be excluded because such a copolyamide would be considered to have different properties than a homogeneous, transamidized blend of at least 2 polyamides, even if the mole percentage of the monomer residues are equivalent.

Similarly, another embodiment of the instant invention is an oxygen-scavenging composition consisting essentially of:

(A) an immiscible blend consisting essentially of

(i) first component consisting essentially of at least one thermoplastic polymer selected from polyester, polycarbonate, polyarylate, and homogeneous blends thereof;

(ii) a second component consisting essentially of a copolyamide or a transamidized, homogeneous blend of at least two polyamides;

wherein the second component (ii) and the first component (i) have a difference in refractive index, RI(second component) - RI(first component), of about 0.006 to about -0.0006, and the blend has a percent transmittance of at least 75%, and a haze of 10% or less; and

(B) at least one metal selected from Groups 3-12, Rows 4-6 of the Periodic Table of the Elements;

In this embodiment, the composition is understood to exclude any elements that would substantially alter the essential properties of the composition to which the phrase refers, such as, for example, the refractive index of the components, %haze of the blend, the %transmittance, the miscibility of the blend, or the oxygen-scavenging proportions of the composition. For example, the addition an oxygen-scavenging component other than a copolyamide or a transamidized blend of polyamides such as, for example, a diene, polyether, or any easily oxidizable organic compound other than the components as listed in the claims would be excluded.

The polyamides used in the present invention typically are prepared from dicarboxylic acids and diamines, which react in substantially equal proportions, or by the ring-opening polymerization of lactams, and are incorporated into the polyamide polymer as their corresponding residues. The polyamides derived from dicarboxylic acid and diamine
residues of the present invention, therefore, contain substantially equal molar proportions of acid residues (100 mole percent) and diamine residues (100 mole percent) such that the total moles of repeating units is equal to 100 mole percent. The mole percentages provided in the present disclosure, therefore, may be based on the total moles of acid residues, the total moles of diamine residues, or the total moles of repeating units. For example, a polyamide or copolyamide containing 30 mole percent terephthalic acid, based on the total acid residues, means that the copolyamide contains 30 mole percent terephthalic residues out of a total of 100 mole percent acid residues. Thus, there are 30 moles of terephthalic residues among every 100 moles of acid residues. In another example, a copolyamide containing 30 mole percent m-xylene diamine, based on the total diamine residues, means that the copolyester contains 30 mole percent m-xylene diamine residues among every 100 moles of diamine residues.

[0069] Any method known in the art can be used to produce the polyamides. The polyamides are generally prepared by melt phase polymerization from a diacid-diamine complex which may be prepared either in situ or in a separate step. In either method, the diacid and diamine are used as starting materials. Alternatively, an ester form of the diacid may be used, preferably the dimethyl ester. If the ester is used, the reaction must be carried out at a relatively low temperature, generally 80 to 120°C, until the ester is converted to an amide. The mixture is then heated to the polymerization temperature. In the case of polycaprolactam, either caprolactam or 6-aminocaproic acid can be used as a starting material and the polymerization may be catalyzed by the addition of adipic acid/hexamethylen diamine salt which results in a nylon 6/66 copolymer. When the diacid-diamine complex is used, the mixture is heated to melting and stirred until equilibration.

[0070] The molecular weight is controlled by the diacid-diamine ratio. An excess of diamine produces a higher concentration of terminal amino groups. For oxygen-scavenging compositions, it is advantageous to adjust the diacid-diamine ratio to produce the concentration of terminal amine groups to 20 mmole/kg or less. If the diacid-diamine complex is prepared in a separate step, excess diamine is added prior to the polymerization. The polymerization can be carried out either at atmospheric pressure or at elevated pressures.

[0071] To exhibit satisfactory clarity and low haze, the second component and first component of the immiscible blend typically have refractive indices which differ by about 0.006 to about -0.0006, that is, the RI(second component) - RI(first component) is about 0.006 to about -0.0006. Other examples of differences in the absolute value of the refractive indices are about 0.005 to about -0.0006, about 0.004 to about -0.0006, about 0.003 to about -0.0006, about 0.005 to about -0.0005, and about 0.004 to about -0.0005. Persons of skill in the art will understand, however, that the difference in refractive indices which may be acceptable depends on the blend composition, particle diameter, refractive index, wavelength, and particle structure as described by Biancardi et al., Die Angew. Makromole. Chemie, 183, 221 (1990).

[0072] The immiscible blend of the instant invention has excellent clarity and has a % transmittance of at least 75%, as determined by ASTM Method D1003, and a haze of 10% or less. Other examples of % transmittance are at least 77%, at least 80%, and at least 85%. Additional examples of haze values which may be exhibited by the blends of the invention are 9% or less, 7% or less, 5% or less, and 3% or less. For the compositions of the invention, haze is determined by molding or casting the composition into a sheet or film having a thickness of 1/8 inch or less and measuring the haze according to the procedure described in the examples. For shaped articles, including multilayer shaped articles, the haze can be determined by cutting out a small (i.e., 1 X 1 cm) section of the article, having a thickness of 1/8 inch or less, and measuring the haze according the procedure given in the examples.

[0073] The first component also may comprise homogeneous blend of one or more polymers. For example, the first component may comprise a homogeneous blend of a first polyester with one or more polymers chosen from a polycarbonate, a second polyester, and a polyarylate. The polyester may be any polyester as described herein. For example, the first component may comprise a homogeneous blend of a polyester and a polycarbonate comprising the residues of bisphenol A.

[0074] The polycarbonate may comprise about 90 to 100 mole percent, based on the total moles of diol residues, of the residues bisphenol A, and from 0 to about 10 mole percent of the residues of one or more modifying aliphatic diols or dihydroxy phenols having from 2 to 16 carbons. Representative examples include bis(4-hydroxyphenyl)methane; 2,2-bis(4-hydroxyphenyl) propane ("bisphenol-A"); 2,2-bis(4-hydroxy-3-methylphenyl) propane; 4,4-bis(4-hydroxyphenyl) heptane; 2,2-bis(4-hydroxy-3,5-dibromophenyl) propane; 2,2-bis(4-hydroxy-3,5-dichlorophenyl) propane; dihydric phenol ethers such as, for example, bis(4-hydroxyphenyl)ether; bis(3,5-dichloro-4-hydroxyphenyl)ether; dihydroxy diphenyl ethers such as, for example, p,p' -dihydroxy diphenyl, 3,3' -dichloro-4,4' -dihydroxy diphenyl; dihydroxyaryl sulfones such as, for example, bis(4-hydroxyphenyl)sulfone; bis(3,5-dimethyl-4-hydroxyphenyl)sulfone; dihydroxy benzenes such as, for example, resorcinol; hydroquinone; halo- and alkylsubstituted dihydroxy benzenes such as, for example, 1,4-dihydroxy-2,5-dichlorobenzene; 1,4-dihydroxy-3-methylbenzene; and dihydroxy diphenyl sulfones such as, for example, bis(4-hydroxyphenyl)sulfone; and bis(3,5-dibromo-4-hydroxyphenyl) sulfone. A variety of additional dihydric phenols are also available such as are disclosed, for example, in U.S. Patent No. 's 2,999,835; 3,028,365 and 3,153,008. Also suitable are copolymers prepared from the above dihydric phenols copolymerized with halogen-containing dihydric phenols such as 2,2-bis(3,5-dichloro-4-hydroxyphenyl) propane and 2,2-bis(3,5-dibromo-4-hydroxyphenyl) propane. It is also possible
the present invention, however, can be prepared by the melt method, but not by the solution-prepared method. The melt blending method is more economical and safer than the solution method, which requires the use of volatile solvents. The melt blending method also is more effective in providing clear blends. Any of the clear blends of the present invention that can be prepared by solution blending also can be prepared by the melt method. Some of the blends of the present invention, however, can be prepared by the melt method, but not by the solution-prepared method. Any
blending process which provides clear blends of the present invention is suitable. One of ordinary skill in the art will be
able to determine appropriate blending methods for producing the clear blends of the present invention.

These first and second components of the composition may be compounded in the melt, for example, by using
a single screw or twin screw extruder. They may also be prepared by blending in solution. Additional components such
as stabilizers, flame retardants, colorants, lubricants, release agents, impact modifiers, and the like may also be incor-
porated into the formulation. For example, the compositions can be produced via a melt extrusion compounding of the
first component and the second component with any other composition components such as, for example, metal catalysts,
dyes, toners, fillers, and the like. The composition may be formed by dry blending solid particles or pellets of each of
thermoplastic polymers and the polyamide components and then melt blending the mixture in a suitable mixing means
such as an extruder, a roll mixer, or the like. When a transamidized, homogeneous blend of polyamides is used as the
second component, it is advantageous to conduct the processing at a temperature that will cause transamidation between
the polyamides to occur. Typically, these temperatures range from about 270°C to about 350°C. Other examples of
transamidation temperatures are about 280°C to about 350°C and about 290°C to about 340°C. Blending is conducted
for a period of time that will yield a well dispersed, immiscible blend. Such may easily be determined by those skilled in
the art. If desired, the composition may be cooled and cut into pellets for further processing, it may be extruded into
films, sheets, profiles, and other shaped elements, injection or compression molded to form various shaped articles, or
it may be formed into films and optionally uniaxially or biaxially stretched by means well known in the art.

The amounts of the first and second components in the immiscible blend may vary widely. For example, the
immiscible blend of our novel composition may comprise about 5 to about 99 weight percent of the first component and
about 95 to about 1 weight percent of the second component, based on the total weight of the composition. Other non-
limiting, representative examples of weight percentages of the first and second components include about 50 to about
99 weight percent of the first component and about 50 to about 1 weight percent of the second component, about 60 to
about 99 weight percent of the first component and about 40 to about 1 weight percent of the second component, and
about 70 to about 99 weight percent of the first component and about 30 to about 1 weight percent of the second
component.

The invention also provides a composition comprising an immiscible blend prepared by a process comprising
melt blending:

(i) a first component comprising at least one thermoplastic polymer selected from polyesters, polycarbonates,
polyarylates, and homogeneous blends thereof; and
(ii) a second component comprising a homogeneous, transamidized blend of at least 2 polyamides;

wherein the second component (ii) and the first component (i) have a difference in refractive index, \( \Delta n \), of about 0.006 to about -0.0006, and the immiscible blend has a percent transmittance of at least
75%, and a haze of 10% or less. The composition includes the various embodiments of the polyesters, polycarbonates,
polyarylates, homogeneous blends, and polyamides as described above and any combination thereof. For example,
the second component of the composition can comprise a homogeneous, transamidized blend of at least 2 polyamides
in which transamidation may be accomplished by contacting the polyamides at elevated temperatures, typically from
about 270°C to about 350°C. Other examples of transamidation temperatures are about 280°C to about 350°C and
about 290°C to about 340°C.

The homogeneous blend of component (ii) can comprise a first polyamide, comprising aromatic residues, and
a second polyamide comprising aliphatic residues, as described previously. For example, typical polyamides that can
be used as the second polyamide include, but are not limited to, nylon 4; nylon 6; nylon 9; nylon 11; nylon 12; nylon 6,6;
nylon 5,10; nylon 6,12; nylon 6,11; nylon 10,12; and combinations thereof. In addition to the polyesters described
previously, the first component can comprise a homogeneous blend of a polyester and a polycarbonate comprising the
residues of bisphenol A.

Another aspect of the instant invention is a method for the preparation of a transparent polymer blend, com-
prising:

(A) selecting a first component comprising at least one thermoplastic polymer selected from polyesters, polycar-
bonates, polyarylates, and homogeneous blends thereof;
(B) determining the refractive index of the first component;
(C) providing a second component comprising

(i) a copolyamide having a mole ratio of aliphatic and aromatic residues, wherein the mole ratio of aliphatic and
aromatic residues is selected to produce a second component refractive index that satisfies the following formula:
or:

(ii) a homogeneous, transamidized blend of a first and second polyamide, at least one of the polyamides having aromatic residues, wherein the weight percentage of the first and second polyamide is selected to produce a second component refractive index that satisfies the following formula:

\[ 0.006 \geq RI(\text{second component}) - RI(\text{first component}) \geq -0.0006 \]

wherein \( RI \) is refractive index; and

(D) melt blending the first and second components to produce an immiscible blend having a percent transmittance of at least 75%, and a haze of 10% or less.

Our method includes the various embodiments of the polyesters, polycarbonates, polyarylates, homogeneous blends, copolyamides, and polyamides as described previously and any combination thereof. Our method comprises selecting the first component which may be a polyester, polycarbonate, polyarylate or homogeneous blend thereof. The refractive index of the first component may be determined using methods well known to persons skilled in the art. The second component, which may comprise as single copolyamide or a transamidized, homogeneous blend of at least two polyamides, is tailored to closely match the refractive index of the first component by selecting the appropriate mixture of aromatic and aliphatic monomers in the case of a copolyamide, or by selecting a mixture of polyamides containing the desired mixture of aromatic and aliphatic residues if a homogeneous blend of polyamides is used. The choice of the proper ratio of monomers or of polyamides can be determined, for example, by trial and error, or, in another example, by plotting the refractive index of various polyamides or copolyamides containing varying amounts of aromatic residues and aliphatic residues, and selecting the molar ratio of aromatic:aliphatic residues or the weight percentage ratio of polyamides that will give the targeted refractive index. The first and second components may be melt blended. When the second component comprises a transamidized, homogeneous blend of at least 2 polyamides, it is desirable to carry out the melt blending step at a temperature effective for the transmidation process. Typical transmidation temperature ranges are as described previously.

[0089] The thermoplastic polymers also may be selected to match the refractive index of the second component. Thus, another aspect of the invention is a method for the preparation of a transparent polymer blend, comprising:

(A) selecting a second component comprising

(i) a copolyamide having a mole ratio of aliphatic and aromatic residues; or
(ii) a homogeneous, transamidized blend of a first and second polyamide, at least one of the polyamides having aromatic residues;

(B) determining the refractive index of the second component;

(C) providing a first component comprising at least one thermoplastic polymer selected from polyesters, polycarbonates, polyarylates, and homogeneous blends thereof wherein the polyester, polycarbonate, polyarylate, or homogeneous blend thereof is selected to produce a first component refractive index that satisfies the following formula:

\[ 0.006 \geq RI(\text{second component}) - RI(\text{first component}) \geq -0.0006 \]

wherein \( RI \) is refractive index; and

(D) melt blending the first and second components to produce an immiscible blend having a percent transmittance of at least 75%, and a haze of 10% or less. It is further understood that the above method also includes any combination of the various embodiments of the polyesters, polycarbonates, polyarylates, homogeneous blends, copolyamides, polyamides described previously.

[0090] In one example, the blending of thermoplastic polymers to obtain a second component and first component that have a difference in refractive index of about 0.006 to about -0.0006 may be illustrated with particular reference to polycarbonate/polyester blends. For example, the complete miscibility of a polycarbonate of bisphenol A and PCTG permits the tailoring of refractive index (RI) of the polycarbonate/PCTG blend, by adjusting the polycarbonate/PCTG...
The oxygen-polyamides described hereinabove.

It should be further understood the oxygen scavenging compositions include any combination of the various embodiments of the first and second components, polyesters, polycarbonates, polyarylates, homogeneous blends, copolyamides, and polyamides described hereinabove.

The oxygen-scavenging compositions of the invention can include one metal selected from Groups 3-12, Rows 4-6 of the Periodic Table of the Elements.

In addition to a homogeneous blend of one or polyamides, the oxygen-scavenging compositions of the invention also may include a single copolyamide as described hereinabove for the other embodiments of the invention. Thus, the invention also provides an oxygen-scavenging composition comprising:

(A) an immiscible blend comprising

(i) first component comprising at least one thermoplastic polymer selected from polyester, polycarbonate, polyarylate, and homogeneous blends thereof;

(ii) a second component comprising a transamidized, homogeneous blend of at least two polyamides;

wherein the second component (ii) and the first component (i) have a difference in refractive index, RI(second component) - RI(first component), of about 0.006 to about -0.0006, and the immiscible blend has a percent transmittance of at least 75%, and a haze of 10% or less; and

(B) at least one metal selected from Groups 3-12, Rows 4-6 of the Periodic Table of the Elements.

In addition to a homogeneous blend of one or polyamides, the oxygen-scavenging compositions of the invention also may include a single copolyamide as described hereinabove for the other embodiments of the invention. Thus, the invention also provides an oxygen-scavenging composition comprising:

(A) an immiscible blend comprising

(i) first component comprising at least one thermoplastic polymer selected from polyester, polycarbonate, polyarylate, and homogeneous blends thereof;

(ii) a second component comprising a copolyamide;

wherein the second component (ii) and the first component (i) have a difference in refractive index, RI(second component) - RI(first component), of about 0.006 to about -0.0006, and the immiscible blend has a percent transmittance of at least 75%, and a haze of 10% or less; and

(B) at least one metal selected from Groups 3-12, Rows 4-6 of the Periodic Table of the Elements.

It should be further understood the oxygen scavenging compositions include any combination of the various embodiments of the first and second components, polyesters, polycarbonates, polyarylates, homogeneous blends, copolyamides, and polyamides described hereinabove.

The clear blends of the present invention can still be modified by the incorporation of modifying polymers to produce performance blends, which may not necessarily be clear. For example, polyamides such as nylon 6,6 from DuPont, poly(ether-imides) such as ULTEM poly(ether-imide) from General Electric, polyphenylene oxides such as pol(2,6-dimethylphenylene oxide) or pol(phenylene oxide)/polystyrene blends such as the NORYL resins from General Electric, polyesters, polyphenylene sulfides, poly(ester-carbonate) such as LEXAN 3250 poly(ester-carbonate) (General Electric), polycarbonates other than LEXAN polycarbonate from General Electric, polyarylates such as ARDEL D100 polyarylate (Amoco), polysulfones; polysulfone ethers, poly(ether-ketones) or aromatic dihydroxy compounds can be used as blend modifiers to modify properties or to reduce flammability. Some of the aromatic dihydroxy compounds used to prepare these polymers are disclosed in U.S. Pat. No. 3,030,335 and U.S. Pat. 3,317,466.

The barrier properties may be enhanced by incorporating a metal catalyst to produce an oxygen scavenging composition which catalyzes the reaction of oxygen with one or more polyamides in the composition. Our invention, therefore, further provides an oxygen-scavenging composition comprising:

(A) an immiscible blend comprising

(i) first component comprising at least one thermoplastic polymer selected from polyester, polycarbonate, polyarylate, and homogeneous blends thereof;

(ii) a second component comprising a transamidized, homogeneous blend of at least two polyamides;

wherein the second component (ii) and the first component (i) have a difference in refractive index, RI(second component) - RI(first component), of about 0.006 to about -0.0006, and the immiscible blend has a percent transmittance of at least 75%, and a haze of 10% or less; and

(B) at least one metal selected from Groups 3-12, Rows 4-6 of the Periodic Table of the Elements.
4-6 of the Periodic Table of the Elements as set forth in the 1984 revision of the Periodic Table by the Internation Union of Pure and Applied Chemistry. Typical oxidation catalysts include transition metal catalysts which can readily interconvert between at least two oxidation states. Examples of metals which can be used include copper, nickel, cobalt, iron, manganese, and combinations thereof. Any amount of catalyst which is effective in catalyzing oxygen scavenging may be used but, typically, the metal will be used in amounts from about 10 ppm to about 1,000 ppm. Other ranges of metal concentration include, about 50 ppm to about 750 ppm, about 10 to about 500 ppm, about 50 ppm to about 500 ppm, and about 50 to about 300 ppm based on the total weight of the oxygen-scavenging composition. The metals typically may be used as the elemental metal itself, as a metal complex containing organic ligands, as an oxide, or as a metal salt. Examples of counterions for metal salts include, but are not limited to, chloride, acetate, acetylace tone, stearate, palmitate, 2-ethylhexanoate, neodecanoate, octanoate, or naphthenate, and mixtures thereof. The metal salt may also be an ionomer, in which case a polymeric counterion is employed. Such ionomers are well known in the art.

In one example, the metal catalyst is cobalt or a compound containing cobalt such as, for example, a cobalt salt. The cobalt may be in the +2 or +3 oxidation state. Other examples of metal catalysts are rhodium in the +2 oxidation state and copper in the +2 oxidation state. The metals may be added in salt form, conveniently as carboxylate salts such as, for example, cobalt octanoate, cobalt acetate, or cobalt neodecanoate. The reported amounts are based on the weight of the polymer blends and measured on the metal, not its compound weight as added to the composition. In the case of cobalt as the metal, typical amounts are at least 50 ppm, or at least 60 ppm, or at least 75 ppm, or at least 100 ppm, or at least 125 ppm. The catalyst can be added neat or in a carrier (such as a liquid or wax) to an extruder or other device for making an article, or it can be added in a concentrate with a polyamide polymer, in a concentrate with a polyester polymer, or in a concentrate with the immiscible blend. The carrier may either be reactive or nonreactive with the first and second component and either volatile or non-volatile carrier liquids may be employed. The metal catalyst may be added at a variety of points and by way of a variety of blending protocols during the preparation of the oxygen scavenging composition. A particularly useful approach is to bring the polyamide and transition metal together late in the preparation of the final blend composition, even as late as in the final melt step before forming the article, so that the oxygen scavenging activity of the polyamide is not prematurely initiated. In some instances, such as when cobalt is provided as a transition metal, it may be preferred to add the cobalt during blending of first and second components, instead of, for example, during the preparation of the thermoplastic polymers.

In one embodiment, for example, the first component of the oxygen-scavenging composition can comprise a polyester having any combination of monomer residues as described previously. For example, the polyester can comprise (a) diacid residues comprising at least 80 mole percent, based on the total diacid residues, of the residues of at least one dicarboxylic acid selected from terephthalic acid, isophthalic acid, naphthalenedicarboxylic acid, and 1,4-cyclohexanedicarboxylic acid, and 0 to about 20 mole percent of the residues of at least one modifying dicarboxylic acid having 2 to 20 carbon atoms; and (b) diol residues comprising at least 80 mole percent, based on the total moles of diol residues, of the residues of at least one diol selected from ethylene glycol, 1,4-cyclohexanedi methanol; neopentyl glycol, diethylene glycol, 1,3-propanediol, 1,4-butanediol, and, 2,2,4,4-tetramethyl-1,3-cyclobutanediol, and from 0 to about 20 mole percent of the residues of at least one modifying diol having from 3 to 16 carbons. In another example, the diacid residues can comprise about 60 to 100 mole percent of the residues of terephthalic acid and 0 to about 40 mole percent of the residues of isophthalic acid and the diol residues can comprise about 100 mole percent of the residues of 1,4-cyclohexanedi methanol. In another example, the diacid residues can comprise about 100 mole percent, based on the total moles of diacid residues, of the residues of terephthalic acid. Other specific examples of polyesters that may be used as the first component include polyesters comprising: (i) about 80 to about 100 mole percent of the residues of terephthalic acid and about 50 to about 90 mole percent of the residues 1,4-cyclohexanemethanol and about 10 to about 50 mole percent neopentyl glycol; (ii) about 100 mole percent of the residues of terephthalic acid and about 10 to about 40 mole percent of the residues of 1,4-cyclohexanemethanol, and about 60 to about 90 mole percent of the residues of ethylene glycol; and (iii) about 100 mole percent of the residues of terephthalic acid and about 10 to about 99 mole percent of the residues of 1,4-cyclohexanemethanol, 0 to about 90 mole percent of the residues of ethylene glycol, and about 1 to about 25 mole percent of the residues of diethylene glycol. The polyester may also further comprise about 0.1 to 2 mole%, based on the total diacid residues, of the residues of at least one branching agent selected from trimellitic acid, trimellitic anhy dride, and pyromellitic dianhydride as described hereinabove.

The first component may also comprise a homogeneous blend of at least one polyester and at least one polycarbonate. The polycarbonates that can be used in these homogeneous blends have been described previously.

The transamidized, homogeneous blend or the copolyamide can comprise any polyamide as described previously such as for example, various nylons. It is advantageous, however, that the copolyamide or homogeneous blend of polyamides of the oxygen-scavenging composition comprise the residues of m-xylylenediamine, p-xylylenediamine, or a combination thereof. For example, the second component may comprise a homogeneous blend of a first polyamide comprising the residues of m-xylylenediamine and adipic acid, and a second polyamide comprising nylon 6, nylon 6,6, or blends thereof. As a further example, this homogeneous blend may be combined in an immiscible blend with a first component comprising a homogeneous blend of the polyester and a polycarbonate comprising the residues of bisphenol 20
A. It is desirable also for optimum oxygen scavenging properties that the copolyamide or homogeneous blend of polyamides contain 20 mmoles/kg or less of free amino groups. The concentration of free amino groups can be determined using techniques well known to persons having ordinary skill in the art such as, for example, by titration.

[0100] In another example, the oxygen scavenging composition comprises a copolyamide of m-xylylenediamine adipate. The use of a modified m-xylylenediamine adipate, in which some of the adipic acid residues, or some of the m-xylylenediamine residues, or both, are replaced with other residues, can give an oxygen-scavenging composition with improved oxygen-scavenging properties when compared with compositions containing only the m-xylylenediamine adipate homopolymer. Other polyamide barrier polymers, as described herein, may also be used as part of the oxygen scavenging composition.

[0101] The compositions of the present invention described hereinabove may be used to fabricate shaped articles such as, for example, sheets, films, tubes, preforms, bottles, or profiles. Such articles may be formed by any means well known to persons skilled in the art such as, for example, by extrusion, calendering, thermoforming, blow-molding, extrusion blow-molding, injection molding, compression molding, casting, drafting, tentering, or blowing.

[0102] For example, the compositions of the present invention may be fabricated into shaped articles such as, for example, films, by any technique known in the art. Formation of films can be achieved by melt extrusion, as described, for example, in U.S. Patent No. 4,880,592, or by compression molding as described, for example, in U.S. Patent No. 4,427,614, or by any other suitable method. For example, films may be produced by the well known cast film, blown film and extrusion coating techniques, the latter including extrusion onto a substrate. Such a substrate may also include a tie-layer. Films produced by melt casting or blowing can be thermally bonded or sealed to a substrate using an adhesive. The compositions may be fabricated into monolayer or multilayer films by any technique known in the art. For example, monolayer, or multi-layer films may be produced by the well known cast film, blown film and extrusion coating techniques, the latter including extrusion onto a substrate. Representative substrates include films, sheets, and woven and nonwoven fabrics. Monolayer, or multilayer films produced by melt casting or blowing can be thermally bonded or sealed to a substrate using an adhesive.

[0103] For example, the composition may be formed into a film using a conventional blown film apparatus. The film forming apparatus may be one which is referred to in the art as a "blown film" apparatus and includes a circular die head for bubble blown film through which the composition is forced and formed into a film "bubble". The "bubble" is ultimately collapsed and formed into a film.

[0104] The compositions also may be used to form shaped articles through extrusion blow molding and injection stretch-blow molding. An injection molding process softens the copolyamide or homogeneous polyamide blend in a heated cylinder, injecting it while molten under high pressure into a closed mold, cooling the mold to induce solidification, and ejecting the molded preform from the mold. Molding compositions are well suited for the production of preforms and subsequent reheat stretch-blow molding of these preforms into the final bottle shapes having the desired properties. The injection molded preform is heated to suitable orientation temperature in the 100°C to 150°C range and then stretch-blow molded. The latter process consists of first stretching the hot preform in the axial direction by mechanical means such as by pushing with a core rod insert followed by blowing high pressure air (up to 500 psi) to stretch in the hoop direction. In this manner, a biaxially oriented blown bottle is made. Typical blow-up ratios range from 5/1 to 15/1.

[0105] The excellent transparency and low haze of the compositions of the invention enable the preparation of transparent, shaped articles with the incorporation of substantial amounts of scrap polymer or "regrind". The term "regrind", as used herein, is understood to have its commonly accepted meaning in art, that is, scrap polymer that recovered from an article forming process and ground into smaller particles. Often, regrind is sold as scrap for incorporation into shaped articles in which the transparency of the article is immaterial to its application. For certain shaped articles such as, for example, bottles and films used in packaging applications, low haze and high transparency are important features. The manufacture of these articles, in particular, multilayered articles, inherently produces large quantities of scrap polymer which frequently cannot be returned to the article-forming process because of the formation of unacceptable levels of haze. Because of the close match in the refractive indices of the first and second components, low haze, transparent, shaped articles may be produced from the compositions of the invention with the inclusion of regrind.

[0106] Another aspect of our invention, therefore, is a process for forming a shaped article, comprising:

(A) melt blending

(i) a first component comprising at least one thermoplastic polymer selected from polyesters, polycarbonates, polarylates, and homogeneous blends thereof; and

(ii) a second component comprising a copolyamide or a homogeneous, transamidized blend of at least 2 polyamides;

wherein the first component (i) and second component (ii) form an immiscible blend, the second component and the first component have a difference in refractive index, \(RI(\text{second component}) - RI(\text{first component})\), of about
0.006 to about -0.0006, and the immiscible blend has a percent transmittance of at least 75%, and a haze of 10% or less;

(B) forming a shaped article;

(C) recovering a scrap polymer composition comprising the blended first and second components (i) and (ii);  

(D) grinding the scrap polymer composition to produce a polymer regrind;

(E) optionally, drying the scrap polymer composition; and  

(F) combining the polymer regrind with the first and second components (i) and (ii) of step (A).  

Our process, thus, permits the incorporation of scrap polymer regrind into the shaped article with retention of low haze and high transparency. It should be further understood the above process includes the various embodiments of the first and second components, polyesters, polycarbonates, polyarylates, homogeneous blends, copolyamides, polyamides, oxygen-scavenging compositions, and any combination thereof described hereinabove.

[0107] For example, as described previously, the immiscible blend formed from the first and second components may further comprise at least one metal selected from Groups 3-12, Rows 4-6 of the Periodic Table of the Elements. Examples of metals include copper, nickel, cobalt, iron, manganese, and combinations thereof. Typically, the metal is present in amounts of about 10 to about 500 parts per million by weight of the metal, based on the total weight of the shaped article. The preferred metal is cobalt.

[0108] The shaped article of our inventive process may be formed by any methods known in the art and described hereinabove. For example, the shaped article may be formed by extrusion, calendering, thermoforming, blow-molding, extrusion blow-molding, injection molding, compression molding, casting, drafting, tentering, or blowing.

[0109] Although the process of the invention may be used to prepare any shaped article, representative articles that may be produced are sheets, films, preforms, tubes, and bottles. These articles may have a single layer or contain from 2 to about 7 layers. The regrind may be incorporated into one or more of these layers which may comprise from about 50 to 100 weight percent regrind based on the weight of the one or more layers. Other examples of regrind levels that can be present in the shaped article are about 5 to about 95 weight percent, about 10 to about 60 weight percent, about 15 to about 50 weight percent, and about 20 to about 30 weight percent.

[0110] The shaped article may comprise multiple layers in which one or more of the layers comprise the first and second component as an immiscible blend or in which the first component and the second component are present in separate layers. Thus, another aspect of the instant invention, is a multilayered, shaped article, comprising:

(i) a first layer comprising at least one thermoplastic polymer selected from polyester, polycarbonate, polyarylate, and homogeneous blends thereof; and

(ii) a second layer comprising a transamidized homogeneous blend of at least two polyamides;  

wherein the second layer (ii) and the first layer (i) have a difference in refractive index, \( R_I(\text{second layer}) - R_I(\text{first layer}) \), of about 0.006 to about 0.0006, and the shaped article has a percent transmittance of at least 75%, and a haze of 10% or less.

The shaped article may include the various embodiments of the first and second components, polyesters, polycarbonates, polyarylates, homogeneous blends, copolyamides, polyamides, oxygen-scavenging compositions, shaped articles, and any combination thereof described hereinabove.

[0111] The multilayered shaped article may be produced by extrusion, calendering, thermoforming, blow-molding, extrusion blow-molding, injection molding, compression molding, casting, drafting, tentering, or blowing. Because of the close match between the refractive indices of the first and second layers, the multilayered article may further comprise a regrind comprising a mixture of the first and second layers, which may be incorporated into first layer, second layer, or a combination of the first and second layer. Typically, the regrind is about 5 weight percent to about 60 weight percent of the multilayered article, based on the total weight of the article. Other examples of weight percentages of regrind in the shaped article are about 10 weight percent to about 40 weight percent and about 20 weight percent to about 30 weight percent of the total weight of the article.

[0112] The multilayered article can have from 2 to about 7 layers depending on its intended application. For example, as described above, the shaped article may be a sheet, film, tube, bottle, or preform. Complex layered structures are possible also. For example, the shaped article can have a layered structure represented by ABA, ABABA, ABCBA, or ACBCBA in which layer A comprises the first layer (i), layer B comprises the second layer (ii), and layer C comprises a regrind comprising a mixture of scrap first and second layers (i) and (ii), polyester or polycarbonate obtained from post consumer recycle, or a combination thereof. Depending on the composition of the regrind, it can be advantageous that layer B and layer C have a difference in refractive index, \( R_I(\text{layer B}) - R_I(\text{layer C}) \), of about 0.006 to about 0.0006 to maintain the transparency of the article and the ability to incorporate regrind.

[0113] In another embodiment, layer A can comprise the second layer (ii), layer B comprises the first layer (i) and layer C comprises a mixture of scrap first and second layers (i) and (ii), polyester or polycarbonate obtained from post consumer recycle, or a combination thereof. Depending on the composition of the regrind, it can be advantageous that layer B and layer C have a difference in refractive index, \( R_I(\text{layer B}) - R_I(\text{layer C}) \), of about 0.006 to about 0.0006 to maintain the transparency of the article and the ability to incorporate regrind.
propanediol, 1,4- and at least one diol selected from ethylene glycol, 1,4- and (b) diol residues comprising at least 80 mole percent, based on the total moles of diol residues, of the residues of and 0 to about 20 mole percent of the residues of at least one modifying dicarboxylic acid having 2 to 20 carbon atoms; selected from terephthalic acid, isophthalic acid, naphthalenedicarboxylic acid, and 1,4-
comprising at least 80 mole percent, based on the total diacid residues, of the residues of at least one dicarboxylic acid as described earlier. For example, the at least one thermoplastic polymer may comprise a linear or branched polyester comprising at least 80 mole percent, based on the total weight of said shaped article. The preferred metal is cobalt.

As noted above, the multilayered, shaped article may comprise the various embodiments of the shaped articles, thermoplastic polymers, polyamides, immiscible blends, homogeneous blends, and oxygen scavenging compositions as described earlier. For example, the at least one thermoplastic polymer may comprise a linear or branched polyester having from 2 to 20 carbon atoms; and (b) diol residues comprising at least 80 mole percent, based on the total moles of diol residues, of the residues of at least one diol selected from ethylene glycol, 1,4-cyclohexanedicarboxylic acid, and 0 to about 20 mole percent of the residues of at least one modifying dicarboxylic acid having 2 to 20 carbon atoms; and (c) diol residues comprising at least 80 mole percent, based on the total moles of diol residues, of the residues of at least one diol selected from ethylene glycol, 1,4-cyclohexanediol, and 0 to about 20 mole percent of the residues of at least one modifying dicarboxylic acid having from 3 to 16 carbons; and the one or more barrier polymers comprise a homogeneous blend of a first polymer comprising the residues of m-xylene with at least one barrier polymer comprising the residues of the repeating unit [0116] As noted above, the multilayered, shaped article may comprise the various embodiments of the shaped articles, thermoplastic polymers, polyamides, immiscible blends, homogeneous blends, and oxygen scavenging compositions as described earlier. For example, the at least one thermoplastic polymer may comprise a linear or branched polyester comprising at least 80 mole percent, based on the total weight of said shaped article. The preferred metal is cobalt.

In addition, the second layer (ii) of our novel multilayered article can further comprise at least one metal selected from Groups 3-12, Rows 4-6 of the Periodic Table of the Elements. As noted above, the multilayered, shaped article may comprise the various embodiments of the shaped articles, thermoplastic polymers, polyamides, immiscible blends, homogeneous blends, and oxygen scavenging compositions as described earlier. For example, the at least one thermoplastic polymer may comprise a linear or branched polyester comprising at least 80 mole percent, based on the total weight of said shaped article. The preferred metal is cobalt.

The multilayered, shaped articles of the present invention may be prepared by any method known to persons of ordinary skill in the art. For example, the shaped articles can be formed by any conventional technique for forming films, including lamination, extrusion lamination, coinjection, stretch-blow molding and film extrusion blowmolding, and may be illustrated with particular reference to a typical method for making multilayer film by coextrusion. For example, the first and second components, as well as any optional layers, are fed into infeed hoppers of the extruders of like number, each extruder handling the material for one or more of the layers. Typically, for compositions of the present invention, the first and second components each will be heated to a temperature of about Tg + 100°C to about Tg + 300°C before and during extrusion, wherein Tg is the glass transition temperature of the first or second component measured by differential scanning calorimetry. The melted streams from the individual extruders are fed into a single manifold extrusion die. While in the die, the layers are juxtaposed and combined, then emerge from the die as a single layer or multi-layer film of polymeric material. After exiting the die, the film is cast onto a first controlled temperature casting roll, passes around the first roll, and then onto a second controlled temperature roll, which is normally cooler than the first roll. The controlled temperature rolls largely control the rate of cooling of the film after it exits the die. In another method, the film forming apparatus may be one which is referred to in the art as a blown film apparatus and includes a multi-manifold circular die head for bubble blown film through which the film composition is forced and formed into a film bubble which may ultimately be collapsed and formed into a film. Processes of coextrusion to form film and sheet laminates are generally known. Alternatively the individual layers may first be formed into sheets and then laminated together under heat and pressure with or without intermediate adhesive layers.

The transparency and low haze of the compositions of the invention also enable the preparation of multilayered, transparent, shaped articles with the incorporation of substantial amounts of scrap polymer or "regrind". Our invention, therefore, also provides a process for forming a multilayered, shaped article, comprising:

(i) heating a first component comprising at least one thermoplastic polymer selected from polyesters, polycarbonates, polyarylates, and homogeneous blends thereof to a temperature of about Tg +100°C to about Tg + 300°C of the first component;
(ii) heating a second component comprising a copolyamide or a transamidized, homogeneous blend of at least two polyamides to a temperature of about Tg +100°C to about Tg + 300°C of the second component;
(iii) forming a shaped article having the first and second components in separate layers;
(iv) recovering scrap first and second components;
(v) grinding the scrap first and second components to produce a regrind;
(vi) optionally, drying the regrind; and
(vii) combining the regrind with the first component, second component, or a combination thereof, of steps (i) and (ii);
wherein the second component of step (ii) and the first component of step (i) of have a difference in refractive index, RI (second component) - RI(first component), of about 0.006 to about -0.0006, and the shaped article has a percent transmittance of at least 75%, and a haze of 10% or less. The process may include the various embodiments of the first and second components, polyesters, polycarbonates, polyarylates, homogeneous blends, copolyamides, polyamides, oxygen-scavenging compositions, shaped articles, article-forming processes, and any combination thereof described hereinabove.

[0119] Our process enables the incorporation of substantial amounts of regrind into shaped article while maintaining low haze and high transparency. The regrind will typically comprise a mixture of the first and second components of steps (i) and (ii) that are produced as scrap during the article-forming process, but any polymer material can be used as long as its refractive index differs from the that second component by about 0.006 to about -0.0006. The regrind material of the process can be combined with the first component of step (i), the second component of step (ii) or a combination of the first and second components. The regrind can be from about 5 weight percent to about 60 weight percent of the shaped article, based on the total weight of the shaped article. Other representative examples of regrind content for the shaped article of the process of the invention are about 10 weight percent to about 40 weight percent of the shaped article and about 20 weight percent to about 30 weight percent of the shaped article.

[0120] The multilayered article of our process can have from 2 to about 7 layers depending on its intended application. For example, as described above, the multilayered, shaped article may be a sheet, film, tube, bottle, or preform. Complex layered structures are possible also. For example, the shaped article can have a layered structure represented by ABA, ABABA, ABCBA, or ACBBA in which layer A comprises the first component of step (i), layer B comprises the second component of step (i), and layer C comprises a regrind comprising a mixture of scrap first and second components from steps (i) and (ii), polyester or polycarbonate obtained from post consumer recycle, or a combination thereof. Depending on the composition of the regrind, it can be advantageous that layer B and layer C have a difference in refractive index, RI(layer B) - RI(layer C), of about 0.006 to about - 0.0006 to maintain the transparency of the article and the ability to incorporate regrind.

[0121] In another embodiment, layer A can comprise the second component of step (11), layer B comprises the first component of step (i) and layer C comprises a a mixture of scrap first and second components of steps (i) and (ii), polyester or polycarbonate obtained from post consumer recycle, or a combination thereof.

[0122] In addition, the second component of step (ii) of our novel multilayered article can further comprise at least one metal selected from Groups 3-12, Rows 4-6 of the Periodic Table of the Elements. Examples of metals which can be used include copper, nickel, cobalt, iron, manganese, and combinations thereof. Typically, the metal is present in amounts of about 10 to about 500 parts per million by weight of the metal, based on the total weight of the shaped article. The preferred metal is cobalt.

[0123] In yet another embodiment, step (iii) of the process of the invention can further comprise forming at least one additional layer comprising about 50 to about 100 weight percent of regrind, based on the total weight of the layer. The additional layer containing the regrind can further comprise at least one metal selected from Groups 3-12, Rows 4-6 of the Periodic Table of the Elements. Examples of metals include copper, nickel, cobalt, iron, manganese, and combinations thereof. Typically, the metal is present in amounts of about 10 to about 500 parts per million by weight of said metal, based on the total weight of the said shaped article. The preferred metal is cobalt.

[0124] As noted above, the multilayered, shaped article may comprise the various embodiments of the shaped articles, thermoplastic polymers, polyamides, immiscible blends, homogeneous blends, and oxygen scavenging compositions as described earlier. For example, the at least one thermoplastic polymer may comprise a polyester comprising at least 80 mole percent, based on the total diacid residues, of the residues of at least one dicalboxylic acid selected from terephthalic acid, isophthalic acid, naphthalenedicarboxylic acid, and 1,4-cyclohexanedicarboxylic acid, and 0 to about 20 mole percent of the residues of at least one modifying dicalboxylic acid having 2 to 20 carbon atoms; and (b) diol residues comprising at least 80 mole percent, based on the total moles of diol residues, of the residues of at least one diol selected from ethylene glycol, 1,4-cyclohexanediethanol; neopentyl glycol, diethylene glycol, 1,3-propanediol, 1,4-butandiol, and, 2,2,4,4-tetramethyl-1,3-cyclobutanediol; and from 0 to about 20 mole percent of the residues of at least one modifying diol having from 3 to 16 carbons; and the one or more barrier polymers comprise a homogeneous blend of a first polyamide comprising the residues of m-xylylenediamine and adipic acid, and a second polyamide comprising nylon 6, nylon 6,6, or blends thereof. For example, the thermoplastic polymer may comprise a branched polyester. In a further example, the thermoplastic polymer further comprise a homogeneous blend of the polyester and a polycarbonate comprising the residues of bisphenol A.

[0125] Another embodiment of our invention further is a process for forming a multilayered shaped article, comprising:

(A) heating a first component comprising (i) at least one polyester comprising:

(a) diacid residues comprising at least about 95 mole percent, based on the total diacid residues, of the residues of terephthalic acid; and (b) diol residues comprising at least about 95 mole percent, based on the total moles of diol
residues, of the at least one diol selected from ethylene glycol and 1,4-cyclohexanedimethanol; (ii) at least one polycarbonate comprising the residues of bisphenol A; or (iii) a homogeneous blend thereof to a temperature of about Tg + 100°C to about Tg + 300°C of the first component;

(B) heating a second component comprising a transamidized, homogeneous blend of a polyamide comprising diamine and diacid residues, the polyamide comprising about 100 mole percent, based on the total diamine residues, of the residues of m-xylylenediame and about 100 mole percent, based on the total diacid residues, of the residues of adipic acid, and at least one polylamide selected from nylon 6 and nylon 6,6 to a temperature of about Tg + 100°C to about Tg +300°C of the second component;

(C) forming a shaped article having the first and second polymer compositions in separate layers;

(D) recovering scrap first and second components;

(E) grinding the scrap first and second components to produce a regrind;

(F) optionally, drying the regrind; and

(G) combining the regrind with the first component, second component, or a combination thereof, of steps (A) and (B);

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl

wherein the second component of step (B) and the first component of step (B) have a difference in refractive index, Rl
and light stabilizers, dyes, antistatic agents, lubricants, preservatives, processing aids, slip agents, antiblocking agents, pigments, flame retardants, blowing agents, and the like. More than one additive may be used. The additive may be present in any desired amount, but typically are not present at more than about 20 weight percent, preferably not more than 10 weight percent, of the total weight of the shaped article.

The polymer compositions, oxygen-scavenging compositions, and shaped articles prepared therefrom also may comprise up to about 30 weight percent, preferably less than about 20 weight percent, of certain platelet particles derived from at least one layered silicate material to improve their barrier properties. The platelet particles can be modified with at least one ammonium compound. The amount of platelet particles may be determined by measuring the residual ash of the polymer-platelet particle compositions when treated in accordance with ASTM D5630-94. The gas barrier improvement typically increases with increasing concentration of platelet particles in the composite. While amounts of platelet particles as low as about 0.01 percent provide improved barrier (especially when well dispersed and ordered), compositions having at least about 0.5 weight percent of the platelet particles are preferred because they display desirable improvements in gas permeability.

Generally layered silicate materials are a dense agglomeration of platelet particles which are closely stacked together like cards. The platelet particles of the present invention have a thickness of less than about 2 nm and a diameter in the range of about 10 to about 5000 nm. For the purposes of this invention, measurements refer only to the platelet particle and not to the ammonium compounds or any additional dispersing aids and treatment compounds which might be used. Suitable platelet particles are derived from layered silicate materials that are typically free flowing powders having a cation exchange capacity between about 0.3 and about 3 meq/g and preferably between about 0.8 and about 1.5 meq/g. Examples of suitable layered silicate materials include mica-type layered phyllosilicates, including clays, smectite clays, sodium montmorillonite, sodium hectorite, bentonites, nontronite, beidellite, volonoloiote, saponite, sauconite, magadite, kenyite, synthetic sodium hectorites, and the like. Clays of this nature are available from various companies including Southern Clay Products and Nanocor, Inc. The most preferred platelet particles are derived for sodium bentonite or sodium montmorillonite. Such clays are readily available in the U.S., known as Wyoming type montmorillonite, and other parts of the world, including the Kunipia clays available from Kunimine Industries, Inc.

The layered silicate materials are typically treated to improve dispersion into the polymer composition. Many useful clay treatments are known in the art, and these treatments may also be used before, after, or during incorporation of the layered silicate materials into the composites of this invention without deviating from the scope of this invention. Examples of useful treatments include, but are not limited to treatments with silane compounds, expanding agents, polymers and oligomers, dispersing aids, organic cation salts, and their combinations.

Examples of useful treatment with silane compounds include those treatments disclosed in International Public-ation No. WO 93/11190. Examples of useful silane compounds include 3-glycidoxypropyltrimethoxysilane, 2-methoxy(polyethyleneoxy)propyl)heptamethyl trisiloxane, octadecyl dimethyl (3-trimethoxysilyl)propyl) ammonium chloride and the like.

Examples of useful treatment with expanding agents include oligomeric polymers well known in the art. Representative polymers and oligomers for treating clays include those disclosed in U.S. Patent No.’s 5,552,469 and 5,578,672. Many dispersing aids are known, covering a wide range of materials including water, alcohols, ketones, aldehydes, chlorinated solvents, hydrocarbon solvents, aromatic solvents, and the like or combinations thereof.

EXAMPLES

General: The invention is further illustrated by the following examples. The glass transition temperatures (Tg’s) of the polyesters, polyamides, and blends were determined by ASTM Method D3418 using a TA Instruments 2920 differential scanning calorimeter (DSC) at a scan rate of 20°C/min. Heat Deflection Temperature was determined by ASTM Method D648, and Notched Izod Impact Strength was performed according to ASTM Method D256. Flexural properties were determined according to ASTM Method D790. The tensile properties of the blends were determined according to ASTM Method D638 at 23°C. The inherent viscosity of the polyesters was determined in 60/40 (wt/wt) phenol/tetrachloroethane at a concentration of 0.5 g/100 mL at 25°C. The diol content of the polyester portion of these blends was determined by proton nuclear magnetic resonance spectroscopy (1H NMR). The miscibility of the blends was determined by differential scanning calorimetry of pressed films and molded objects.

Haz e values were determined by ASTM Method D1003 (%Haze = 100* Diffuse Transmission / Total Transmission) using a HunterLab UltraScan Sphere 8000 Colorimeter manufactured by Hunter Associates Laboratory, Inc., Reston, VA., using Hunter’s Universal Software (version 3.8). Calibration and operation of the instrument was carried out according to the HunterLab User Manual. Diffuse transmission was obtained by placing a light trap on the other side of the integrating sphere from the sample port, thus eliminating the straight-through light path. Only light scattered by greater than 2.5 degrees was measured. Total transmission includes measurement of light passing straight-through the sample and also off-axis light scattered to the sensor by the sample. The sample was placed at the exit port of the sphere so that off-axis light from the full sphere interior is available for scattering. Clarity was determined visually and with haze.
measurements. For blends and the various compositions of the invention, haze and % transmittance was determined by forming the composition into a sheet, film, or plaque having a thickness of 1/8 inch or less and measuring the haze according to the above procedure. For shaped articles, including multilayer shaped articles, the haze and transmittance was determined by cutting out a small (i.e., 1 X 1 cm) section of the article, having a thickness of 1/8 inch or less, and measuring the haze according the procedure described above.

Refractive index was measured at 633 nm with a Metricon Prism Coupler™ model 2010 refractometer (available from Metricon Inc.) and is reported as the average of the refractive indices measured in 3 orthogonal directions (extrusion or stretch, transverse, and thickness directions). Oriented films were produced on a TM Long film stretcher (named for the producer) which uniaxially or biaxially stretches samples of pressed, blown, or extruded film. The operation of the film stretcher was based upon the movement of two drawbars at right angles to each other upon hydraulically driven rods. There was a fixed draw bar opposed to each moving draw bar. These pairs of opposed moving and fixed draw bars, to which the four edges of the film specimen are attached, form the two axes at right angles to each other along which the specimen is stretched in any stretch ratio up to four or seven times original size, depending on the machine being used. Samples were placed in grips on the machine and heated prior to stretching if desired. The outputs from the device are stress versus elongation data (if desired) at the temperature of the experiment and the stretched film.

Oxygen permeabilities of films were determined using Ox-Tran Oxygen Permeation instruments manufactured by MOCON, Inc. Minneapolis, MN. Oxygen permeabilities were calculated from the known area of the films in test, thickness of the film, partial pressure differential of oxygen across the film, and the measured steady state transmission rate. In the case of samples which exhibit active oxygen scavenging, the measured flux is not truly at steady state, since the transmission rate can slowly change as the efficiency of the oxygen scavenging reaction changes with time. However, in these instances, the oxygen transmission can often be considered to be at pseudo-steady state during the duration of permeation measurement. In the active oxygen scavenger samples included in the examples which follow, little to no change in scavenger efficiency was evident during the course of the measurements and permeabilities were calculated from the measured pseudo-steady state transmission rates.

Comparative Examples 1-12: The copolyesters listed in Table 1 were prepared from terephthalic acid, ethylene glycol, and 1,4-cyclohexanediol (CHDM). The amount of CHDM in the polyesters is shown in Table 1. Examples F contains 100% CHDM (0% ethylene glycol) but 26 mole% of the acid portion is isophthalic acid instead of terephthalic acid.

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyester</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>E</td>
</tr>
<tr>
<td>F</td>
</tr>
</tbody>
</table>

The copolyesters and MXD6 6121 polyamide (containing 100 mole% m-xylylene and 100 mole% adipic acid, available from Mitsubishi Corporation) were dried overnight at 70°C. Each of these copolyesters were bag blended with a MXD6 at 1, 3, and 5 wt% and fed to a Sterling 1.5 inch single screw extruder at 90 rpm under the following temperature settings (degrees C) to form a blend:

<table>
<thead>
<tr>
<th>Zone 1</th>
<th>Zone 2</th>
<th>Zone 3</th>
<th>Zone 4</th>
<th>Zone 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>240</td>
<td>250</td>
<td>260</td>
<td>260</td>
<td>260</td>
</tr>
</tbody>
</table>

The blends were dried overnight at 70°C and then injection molded into 1/8 inch thick 4" square plaques at 270°C on a Toyo 90 injection molding machine. The refractive index of the MXD6 was measured to be 1.5824. The resulting haze values and the result of the subtraction of the refractive index of the polyester from the refractive index of the nylon are shown in Table 2:
Examples 13-24, 27-29, 31-32, 34-36, 38 and Comparative Examples 25-26, 30, 33, 36-37, and 39: Nylon 6 (available as Zytel® 7335F from DuPont) and MXD6 (grade 6121) were dried at 120°C for 48 hours and bag blended in various ratios. Polyamide bag blends were then fed to a Sterling 1.5 inch single screw extruder at 90 rpm under the following conditions (°C) to form a homogeneous, transamidized blend as indicated by the presence of a single, composition dependent Tg value for each blend. The Tg values are shown in Table 3.

Portions of the transamidized nylon blends or MXD6 were dried overnight at 120°C and then either injection molded into 1/8 inch thick samples at 240°C on a Toyo 90 injection molding machine or extruded into 15 mil thick film at 240°C. The films were prepared by the following extrusion process: The extruder used was a conventional 2.54 cm diameter Killian extruder, 24:1 L:D (length:diameter) ratio, fitted with a feed screw with 3:1 compression ratio and twisted maddock mixing section. The conventional feedblock was used to convey the melt to a conventional 15.24 cm coathanger die. A 2-roll cast film downstack configuration was used for quenching the melt. These films were then stretched on the TM-Long 4x in each direction at 95°C. The properties of these films before stretching are shown in Table 3 and after stretching are shown in Table 3A. It should be noted that oxygen permeabilities in Tables 3A were measured at 30°C and 50% relative humidity with 100% O₂ as the test gas.

### Table 2

<table>
<thead>
<tr>
<th>Example</th>
<th>Polyester Type</th>
<th>Polyester (wt%)</th>
<th>MXD6 (wt%)</th>
<th>% Haze</th>
<th>Total Transmission (%)</th>
<th>RI(nylon) - RI (polyester)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-1</td>
<td>A</td>
<td>99</td>
<td>1</td>
<td>5.2</td>
<td>82.8</td>
<td>0.0116</td>
</tr>
<tr>
<td>C-2</td>
<td>A</td>
<td>97</td>
<td>3</td>
<td>14.3</td>
<td>81.6</td>
<td>0.0116</td>
</tr>
<tr>
<td>C-3</td>
<td>A</td>
<td>95</td>
<td>5</td>
<td>29.8</td>
<td>82.0</td>
<td>0.0116</td>
</tr>
<tr>
<td>C-4</td>
<td>B</td>
<td>99</td>
<td>1</td>
<td>5.1</td>
<td>79.5</td>
<td>0.0180</td>
</tr>
<tr>
<td>C-5</td>
<td>B</td>
<td>97</td>
<td>3</td>
<td>22.4</td>
<td>70.7</td>
<td>0.0180</td>
</tr>
<tr>
<td>C-6</td>
<td>B</td>
<td>95</td>
<td>5</td>
<td>42.9</td>
<td>62.4</td>
<td>0.0180</td>
</tr>
<tr>
<td>C-7</td>
<td>C</td>
<td>99</td>
<td>1</td>
<td>8.5</td>
<td>80.7</td>
<td>0.0231</td>
</tr>
<tr>
<td>C-8</td>
<td>C</td>
<td>97</td>
<td>3</td>
<td>31.0</td>
<td>70.4</td>
<td>0.0231</td>
</tr>
<tr>
<td>C-9</td>
<td>C</td>
<td>95</td>
<td>5</td>
<td>50.7</td>
<td>62.6</td>
<td>0.0231</td>
</tr>
<tr>
<td>C-10</td>
<td>D</td>
<td>99</td>
<td>1</td>
<td>11.5</td>
<td>77.6</td>
<td>0.0251</td>
</tr>
<tr>
<td>C-11</td>
<td>D</td>
<td>97</td>
<td>3</td>
<td>59.0</td>
<td>63.3</td>
<td>0.0231</td>
</tr>
<tr>
<td>C-12</td>
<td>D</td>
<td>95</td>
<td>5</td>
<td>81.6</td>
<td>53.5</td>
<td>0.0231</td>
</tr>
</tbody>
</table>

### Table 3 - Film Properties Before Stretching

<table>
<thead>
<tr>
<th>Example</th>
<th>MXD6 (wt%)</th>
<th>Nylon 6 (wt%)</th>
<th>Tg (°C)</th>
<th>Oxygen Permeability (cc<em>mil/100in²</em>day*atm)</th>
<th>Thickness (mil)</th>
<th>Refractive Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>100</td>
<td>0</td>
<td>88</td>
<td>0.533</td>
<td>15.003</td>
<td>1.5824</td>
</tr>
<tr>
<td>14</td>
<td>95</td>
<td>5</td>
<td>87</td>
<td>0.440</td>
<td>15.000</td>
<td>1.5772</td>
</tr>
<tr>
<td>15</td>
<td>90</td>
<td>10</td>
<td>83</td>
<td>0.100</td>
<td>14.465</td>
<td>1.5739</td>
</tr>
<tr>
<td>16</td>
<td>87</td>
<td>13</td>
<td>83</td>
<td>0.063</td>
<td>14.498</td>
<td>1.5724</td>
</tr>
<tr>
<td>17</td>
<td>85</td>
<td>15</td>
<td>81</td>
<td>0.413</td>
<td>14.065</td>
<td>1.5717</td>
</tr>
<tr>
<td>18</td>
<td>75</td>
<td>25</td>
<td>77</td>
<td>1.266</td>
<td>15.260</td>
<td>1.5655</td>
</tr>
<tr>
<td>19</td>
<td>73</td>
<td>27</td>
<td>76</td>
<td>1.060</td>
<td>14.065</td>
<td>1.5641</td>
</tr>
<tr>
<td>20</td>
<td>70</td>
<td>30</td>
<td>75</td>
<td>1.317</td>
<td>14.535</td>
<td>1.5617</td>
</tr>
</tbody>
</table>
To generate examples and comparative examples shown in Table 4, portions of the transamidized blends or MXD6 were dried overnight between 70 and 120°C and then compounded with the polyesters of Table 1. The polyesters were dried overnight between 70 and 120°C. Each of these polyesters of Table 1 were bag blended with 10 wt% of selected transamidized blends of Table 3 or MXD6 and fed to a Sterling 1.5 inch single screw extruder at 90 rpm under the following temperature settings (°C) to form an immiscible blend:

<table>
<thead>
<tr>
<th>Zone 1</th>
<th>Zone 2</th>
<th>Zone 3</th>
<th>Zone 4</th>
<th>Zone 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>240</td>
<td>260</td>
<td>280</td>
<td>280</td>
<td>280</td>
</tr>
</tbody>
</table>

The blends were dried overnight at 70°C and then Injection molded into 1/8 inch thick 4" square plaques at 270°C on a Toyo 90 injection molding machine. The resulting haze values and the result of the subtraction of the refractive index of the polyester from the refractive index of the nylon are shown in Table 4.

To generate example 38 and comparative example C-39, the transamidized blend from example 20 of Table 3 was dried overnight at 70°C and then bag blended with either polyester A or C of Table 1. The polyesters were also dried overnight between 70 and 120°C. The bag blends were then injection molded into 1/8 inch thick 4" square plaques at 270°C on a Toyo 90 injection molding machine. The resulting haze values and the results of the subtraction of the refractive index of the polyester from the refractive index of MXD6 or the nylon blends are shown in Table 4.

### Table 3A - Film Properties After Stretching

<table>
<thead>
<tr>
<th>Example MXD6 (wt%)</th>
<th>Nylon 6 (wt%)</th>
<th>Oxygen Permeability (cc·mil/100 in²·day·atm)</th>
<th>Thickness (mil)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>100</td>
<td>0</td>
<td>0.230</td>
</tr>
<tr>
<td>14</td>
<td>95</td>
<td>5</td>
<td>0.238</td>
</tr>
<tr>
<td>15</td>
<td>90</td>
<td>10</td>
<td>0.263</td>
</tr>
<tr>
<td>16</td>
<td>87</td>
<td>13</td>
<td>0.340</td>
</tr>
<tr>
<td>17</td>
<td>85</td>
<td>15</td>
<td>0.325</td>
</tr>
<tr>
<td>18</td>
<td>75</td>
<td>25</td>
<td>0.499</td>
</tr>
<tr>
<td>19</td>
<td>73</td>
<td>27</td>
<td>1.402</td>
</tr>
<tr>
<td>20</td>
<td>70</td>
<td>30</td>
<td>0.622</td>
</tr>
<tr>
<td>21</td>
<td>65</td>
<td>35</td>
<td>0.215</td>
</tr>
<tr>
<td>22</td>
<td>62</td>
<td>38</td>
<td>0.847</td>
</tr>
<tr>
<td>23</td>
<td>60</td>
<td>40</td>
<td>0.982</td>
</tr>
<tr>
<td>24</td>
<td>0</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

[0146] To generate examples and comparative examples shown in Table 4, portions of the transamidized blends or MXD6 were dried overnight between 70 and 120°C and then compounded with the polyesters of Table 1. The polyesters were dried overnight between 70 and 120°C. Each of these polyesters of Table 1 were bag blended with 10 wt% of selected transamidized blends of Table 3 or MXD6 and fed to a Sterling 1.5 inch single screw extruder at 90 rpm under the following temperature settings (°C) to form an immiscible blend.
Example 40: In this prophetic example, a synthetic route to a polyamide with the appropriate refractive index is employed instead of blending two polyamides as in the above Examples 13-24. Any method known in the art can be used to produce these directly synthetic polyamides. The polyamides are generally prepared by melt phase polymerization from a diacid-diamine complex which may be prepared either in situ or in a separate step. In either method, the diacid and diamine are used as starting materials. Alternatively, an ester form of the diacid may be used, preferably the dimethyl ester. If the ester is used, the reaction must be carried out at a relatively low temperature, generally 80 to 120°C, until the ester is converted to an amide. The mixture is then heated to the polymerization temperature. For this prophetic example, the polyamide synthesized is poly(m-xylylene pimelamide) which is synthesized from the diamine m-xylylenediamine and the diacid pimelic acid. This polyamide is then blended with 90 wt% of the copolyester A in Table 1, in accordance with methods disclosed in Examples 25-39. The difference in refractive index between these the copolyester A and poly(m-xylylene pimelamide) is predicted to be 0.0034 and is predicted to be transparent. The resulting blend is predicted to have a haze value of less 10% and a transmittance of greater than 75%.

Examples 42-43 and 47-49 and Comparative Examples 41, 44-46, and 50-53. Monolayer Films of blends and Oxygen-Scavenging Compositions: Several MXD6/N6 transamidized blends were prepared in the manner discussed above for examples 13-24 and are given in Table 5. The refractive index values listed in Table 5 were measured on 15mil films of these transamidized blends in the manner discussed above for examples 13-24 and are given in Table 5. The refractive index values listed in Table 5 were measured on 15mil films of these transamidized blends in the manner discussed above for examples 13-24. Three wt% or 5 wt% of either these transamidized MXD6/N6 preblends or MXD6 were bag blended with several of the copolyesters from Table 1 as per Table 6. These pellet blends were then dried overnight at 60°C - 70°C and then fed to a Killian 1.0 inch single screw extruder at 95 rpm at the temperatures indicated in table 7 to form nominally 30 mil thick films from the immiscible blend. All films containing pure MXD6 had haze values greater than 10%. The films where the refractive index of nylon blend was matched to the refractive index of corresponding polyester within a range of 0.006 to -0.0006 were clear (haze ≤ 10%).

Table 4 - Polyester blends with homogeneous MXD6/Nylon 6 blends

<table>
<thead>
<tr>
<th>Example</th>
<th>Polyester Type</th>
<th>Blend Example of Table 3</th>
<th>CHDM (mole%) in polyester</th>
<th>Blend MXD6 (wt%)</th>
<th>Blend Nylon 6 (wt%)</th>
<th>Haze %</th>
<th>Total %Trans.</th>
<th>RI(nylon) - RI (polyester)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-25</td>
<td>A</td>
<td>13</td>
<td>1.5</td>
<td>100</td>
<td>0</td>
<td>28.1</td>
<td>71.1</td>
<td>0.0116</td>
</tr>
<tr>
<td>C-26</td>
<td>A</td>
<td>14</td>
<td>1.5</td>
<td>95</td>
<td>5</td>
<td>13.5</td>
<td>76.0</td>
<td>0.0064</td>
</tr>
<tr>
<td>27</td>
<td>A</td>
<td>15</td>
<td>1.5</td>
<td>90</td>
<td>10</td>
<td>6.3</td>
<td>77.8</td>
<td>0.0031</td>
</tr>
<tr>
<td>28</td>
<td>A</td>
<td>16</td>
<td>1.5</td>
<td>87</td>
<td>13</td>
<td>6.9</td>
<td>78.1</td>
<td>0.0016</td>
</tr>
<tr>
<td>29</td>
<td>A</td>
<td>17</td>
<td>1.5</td>
<td>85</td>
<td>15</td>
<td>7.7</td>
<td>77.9</td>
<td>0.0009</td>
</tr>
<tr>
<td>C-30</td>
<td>B</td>
<td>17</td>
<td>31</td>
<td>85</td>
<td>15</td>
<td>21.3</td>
<td>81.8</td>
<td>0.0073</td>
</tr>
<tr>
<td>31</td>
<td>B</td>
<td>18</td>
<td>31</td>
<td>75</td>
<td>25</td>
<td>5.0</td>
<td>86.5</td>
<td>0.0011</td>
</tr>
<tr>
<td>32</td>
<td>B</td>
<td>19</td>
<td>31</td>
<td>73</td>
<td>27</td>
<td>8.5</td>
<td>85.4</td>
<td>-0.0003</td>
</tr>
<tr>
<td>C-33</td>
<td>B</td>
<td>20</td>
<td>31</td>
<td>70</td>
<td>30</td>
<td>16.2</td>
<td>84.1</td>
<td>-0.0027</td>
</tr>
<tr>
<td>34</td>
<td>C</td>
<td>20</td>
<td>50</td>
<td>70</td>
<td>30</td>
<td>4.1</td>
<td>86.8</td>
<td>0.0024</td>
</tr>
<tr>
<td>36</td>
<td>C</td>
<td>21</td>
<td>50</td>
<td>65</td>
<td>35</td>
<td>8.3</td>
<td>84.5</td>
<td>0.0006</td>
</tr>
<tr>
<td>C-36</td>
<td>C</td>
<td>22</td>
<td>50</td>
<td>62</td>
<td>38</td>
<td>13.6</td>
<td>82.8</td>
<td>-0.0018</td>
</tr>
<tr>
<td>37</td>
<td>C</td>
<td>23</td>
<td>50</td>
<td>60</td>
<td>40</td>
<td>19.3</td>
<td>80.2</td>
<td>-0.0057</td>
</tr>
<tr>
<td>38</td>
<td>C</td>
<td>20</td>
<td>50</td>
<td>70</td>
<td>30</td>
<td>3.7</td>
<td>86.3</td>
<td>0.0024</td>
</tr>
<tr>
<td>C-39</td>
<td>A</td>
<td>20</td>
<td>3.5</td>
<td>70</td>
<td>30</td>
<td>33.0</td>
<td>69.9</td>
<td>-0.0091</td>
</tr>
</tbody>
</table>

Table 5 - Homogeneous MXD6 - Nylon 6 Blends

<table>
<thead>
<tr>
<th>Nylon</th>
<th>Composition</th>
<th>Refractive Index</th>
<th>Tg (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W -</td>
<td>Transamidized MXD6/23wt% Nylon 6 preblend</td>
<td>1.5650</td>
<td>78</td>
</tr>
<tr>
<td>X -</td>
<td>Transamidized MXD6130wt% Nylon 6 preblend</td>
<td>1.5617</td>
<td>75</td>
</tr>
</tbody>
</table>
To produce oxygen-scavenging compositions, a concentrate containing cobalt neodecanoate was added to two of the films. This concentrate was prepared as follows. Separate feeds of polyester type C and cobalt neodecanoate, in the form of a pastille and supplied as Cobalt Ten-Cem™ 22.5% (available from OMG Corp.) were fed into a 57mm twin-screw extruder and melt blended at barrel set points of approximately 235°C. Molten polymer exited the extruder in the form of approximate 0.08" diameter strands which were water quenched and cut into approximate 0.125" length pellets. The ratio (by weight) of polyester to polyamide to concentrate was 93:5 to 5 to 1.5 and the concentration of cobalt metal in the concentrate was such that this ratio resulted in about 140 to 150 ppm cobalt in the final blended film. The samples which contained cobalt exhibited excellent oxygen scavenging capacity. These samples, which were mounted on the Ox-Tran permeation instrument 1 week after extrusion, had average apparent permeabilities under these conditions of less than 0.15 cc(STP)*mil/ 100 in²/day/atm for over 6 months.

Table 6 - 30 mil Monolayer Film Results

<table>
<thead>
<tr>
<th>Example</th>
<th>Polyester</th>
<th>Nylon</th>
<th>Melt Temp</th>
<th>% Haze</th>
<th>Total Trans. (%)</th>
<th>RI(nylon) - RI (polyester)</th>
<th>Oxygen Permeability*</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-41</td>
<td>B</td>
<td>3% MXD6</td>
<td>250°C</td>
<td>22.72</td>
<td>88.1</td>
<td>0.0180</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>B</td>
<td>3% W</td>
<td>250°C</td>
<td>1.13</td>
<td>90.5</td>
<td>0.0006</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>C</td>
<td></td>
<td>250°C</td>
<td>0.47</td>
<td>90.8</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>C-44</td>
<td>C</td>
<td>3% MXD6</td>
<td>250°C</td>
<td>35.90</td>
<td>87.8</td>
<td>0.0231</td>
<td></td>
</tr>
<tr>
<td>C-45</td>
<td>C</td>
<td>5% MXD6</td>
<td>280°C</td>
<td>53.57</td>
<td>87.7</td>
<td>0.0231</td>
<td></td>
</tr>
<tr>
<td>C-46</td>
<td>C</td>
<td>5% MXD6 + Co</td>
<td>280°C</td>
<td>34.12</td>
<td>86.2</td>
<td>0.0231</td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>C</td>
<td>3% X</td>
<td>250°C</td>
<td>1.00</td>
<td>90.7</td>
<td>0.0024</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>C</td>
<td>5% X</td>
<td>280°C</td>
<td>0.98</td>
<td>90.6</td>
<td>0.0024</td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>C</td>
<td>5% X + Co</td>
<td>280°C</td>
<td>1.10</td>
<td>90.4</td>
<td>0.0024</td>
<td></td>
</tr>
<tr>
<td>C-50</td>
<td>E</td>
<td>3% MXD6</td>
<td>290°C</td>
<td>27.12</td>
<td>85.6</td>
<td>0.0277</td>
<td></td>
</tr>
<tr>
<td>C-51</td>
<td>E</td>
<td>3% Y</td>
<td>290°C</td>
<td>2.99</td>
<td>90.8</td>
<td>-0.0019</td>
<td></td>
</tr>
<tr>
<td>C-52</td>
<td>F</td>
<td>3% MXDB</td>
<td>250°C</td>
<td>64.06</td>
<td>87.9</td>
<td>0.0305</td>
<td></td>
</tr>
<tr>
<td>C-53</td>
<td>F</td>
<td>3% Z</td>
<td>250°C</td>
<td>2.28</td>
<td>92.3</td>
<td>-0.0047</td>
<td></td>
</tr>
</tbody>
</table>

*apparent permeabilities (average of 2 films per composition and 3 permeability measures per film) fifteen days after mounting on the instrument measured at 23°C and about 60 to 80% relative humidity using air as the upstream test gas.
increase above 10%. The film containing the "C/X" regrind remains clear.

### Table 7

<table>
<thead>
<tr>
<th>Examples</th>
<th>Materials</th>
<th>Haze (%)</th>
<th>Total Transmittance (%)</th>
<th>Haze (%)</th>
<th>Total Transmittance (%)</th>
<th>RI(nylon) - RI (polyester)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-54</td>
<td>C</td>
<td>0.12</td>
<td>91.5</td>
<td>0.09</td>
<td>91.5</td>
<td>n/a</td>
</tr>
<tr>
<td>C-55</td>
<td>C/MXD6/C</td>
<td>1.49</td>
<td>91.1</td>
<td>16.44</td>
<td>87.3</td>
<td>0.0231</td>
</tr>
<tr>
<td>56</td>
<td>C/X/C</td>
<td>0.62</td>
<td>91.2</td>
<td>0.37</td>
<td>91.5</td>
<td>0.0022</td>
</tr>
</tbody>
</table>

### Example and Comparative Examples 57 and 58

Adhesion of multilayer films: ABA films were prepared by co-extruding two 15 mil layers of polyester C around a 4 mil thick layer of either MXD6 or transamidized MXD6/30wt% N6 blend "X". The Nylon 6 used in the transamidized blend in this example was Zytel 7301. A Killian 1" extruder was used to extrude the outer polyester C layers at a temperature of 265°C. A 0.75" Killian extruder was used to extrude the inner layers at the temperatures indicated in Table 8. The transamidized MXD6/30wt% N6 blend "X" shows superior adhesion over MXD6 to polyester C. Furthermore, improved adhesion of the transamidized MXD6/30wt% N6 blend to polyester C was obtained when the inner layer melt temperature was increased from 280°C to 285°C. MXD6 adhesion did not show any temperature dependency.

### Table 8

<table>
<thead>
<tr>
<th>Example</th>
<th>Materials</th>
<th>&quot;B&quot; layer melt temperature</th>
<th>Average Peel Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-57</td>
<td>C/MXD6/C</td>
<td>270°C</td>
<td>1.74</td>
</tr>
<tr>
<td></td>
<td></td>
<td>280°C</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>285°C</td>
<td>1.88</td>
</tr>
<tr>
<td>58</td>
<td>C/X/C</td>
<td>270°C</td>
<td>4.33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>280°C</td>
<td>4.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>285°C</td>
<td>7.14</td>
</tr>
</tbody>
</table>

### Claims

1. An oxygen-scavenging composition comprising:

   (A) an immiscible blend comprising

   (i) first component comprising at least one thermoplastic polymer selected from polyester, polycarbonate, polyarylate, and homogeneous blends thereof;
   (ii) a second component comprising a transamidized, homogeneous blend of at least two polyamides;

   wherein said second component (ii) and said first component (i) have a difference in refractive index, RI(second component) - RI(first component), of 0.006 to 0.0006, and said immiscible blend has a percent transmittance of at least 75%, and a haze of 10% or less; and

   (B) at least one metal selected from Groups 3-12, Rows 4-6 of the Periodic Table of the Elements,

   wherein the refractive index is determined at a wavelength of 633 nm using Metricon Prism Coupler™ Model 2010 refractometer based on the average of the refractive indices measured in 3 orthogonal directions (extrusion or stretch, transverse, and thickness),

   wherein the haze and transmittance are measured according to ASTM Method D1003 on a film, sheet, plaque, or
a 1 x 1 cm section of an article made from the composition having a thickness of 3.175 mm (1/8 inch) or less, and wherein the term "immiscible" denotes a blend that shows at least 2, randomly mixed, phases and exhibits more than one Tg.

2. The oxygen-scavenging composition of claim 1 wherein said second component (ii) is a homogeneous, transamidized blend of at least two polyamides formed by contacting said at least two polyamides at a temperature of about 290°C to about 340°C.

3. The oxygen-scavenging composition of claim 2 wherein said contacting is carried out by melt blending or extruding.

4. The oxygen-scavenging composition of claim 2 which comprises 5 to 99 weight percent of said first component (i) and 95 to 1 weight percent of said second component (ii), based on the total weight of said oxygen-scavenging composition.

5. The oxygen-scavenging composition of claim 4 which comprises 50 to 99 weight percent of said first component (i) and 50 to 1 weight percent of said second component (ii), based on the total weight of said oxygen-scavenging composition.

6. The oxygen-scavenging composition of claim 5 which comprises 70 to 99 weight percent of said first component (i) and 30 to 1 weight percent of said second component (ii), based on the total weight of said oxygen-scavenging composition.

7. The oxygen-scavenging composition of claim 1 wherein said second component (ii) and said first component (i) have a difference in refractive index, RI(second component) - RI(first component), of 0.005 to -0.0006.

8. The oxygen-scavenging composition of claim 1 wherein said at least one thermoplastic polymer comprises a polyester comprising: (a) diacid residues comprising at least 80 mole percent, based on the total diacid residues, of the residues of at least one dicarboxylic acid selected from terephthalic acid, isophthalic acid, naphthalenedicarboxylic acid, and 1,4-cyclohexanedicarboxylic acid, and 0 to 20 mole percent of the residues of at least one modifying dicarboxylic acid having 2 to 20 carbon atoms; and (b) diol residues comprising at least 80 mole percent, based on the total moles of diol residues, of the residues of at least one diol selected from ethylene glycol, 1,4-cyclohexanediol, neopentyl glycol, diethylene glycol, 1,3-propanediol, 1,4-butanediol, and 2,2,4,4-tetramethyl-1,3-cyclobutanediol; and from 0 to 20 mole percent of the residues of at least one modifying diol having from 3 to 16 carbons.

9. The oxygen-scavenging composition of claim 8 wherein said modifying dicarboxylic acid is selected from 4,4'-biphenyldicarboxylic acid, 1,4-naphthalenedicarboxylic acid, 1,5-naphthalenedicarboxylic acid, 2,6-naphthalenedicarboxylic acid, 2,7-naphthalenedicarboxylic acid, 4,4'-oxybenzoic acid, trans-4,4'-stilbenedicarboxylic acid, oxalic acid, malonic acid, succinic acid, glutaric acid, adipic acid, pimelic acid, suberic acid, azelaic acid, and sebacic acid; and said modifying diol is selected from 1,2-propanediol, 1,3-propanediol, 1,4-butanediol, 1,5-pentanediol, 1,6-hexanediol, 1,4-cyclohexanediol, p-xylene glycol, neopentyl glycol, polyethylene glycol, diethylene glycol, polytetramethylene glycol, and 2,2,4,4-tetramethyl-1,3-cyclobutanediol.

10. The oxygen-scavenging composition of claim 8 wherein said diacid residues comprise the residues of one or more dicarboxylic acids selected from terephthalic acid, isophthalic acid, or combinations thereof, and said diol residues comprise the residues of one or more diols selected from 1,4-cyclohexanediol, neopentyl glycol, ethylene glycol, and combinations thereof.

11. The oxygen-scavenging composition of claim 8 which further comprises 0.1 to 2 mole%, based on the total diacid residues, of the residues of at least one branching agent selected from trimellitic acid, trimellitic anhydride, and pyromellitic dianhydride.

12. The oxygen-scavenging composition of claim 8 wherein said diacid residues comprise 60 to 100 mole percent of the residues of terephthalic acid and 0 to 40 mole percent of the residues of isophthalic acid and said diol residue comprises 100 mole percent of the residues of 1,4-cyclohexanediol.

13. The oxygen-scavenging composition of claim 8 wherein said diacid residues comprise 100 mole percent of the residues of terephthalic acid.
14. The oxygen-scavenging composition of claim 8 wherein said diacid residues comprise 80 to 100 mole percent of the residues of terephthalic acid and said diol residues comprise 50 to 90 mole percent of the residues of 1,4-cyclohexanediol and 10 to 50 mole percent of the residues of neopentyl glycol.

15. The oxygen-scavenging composition of claim 8 wherein said diacid residues comprise 100 mole percent of the residues of terephthalic acid and said diol residues comprise 10 to 40 mole percent of the residues of 1,4-cyclohexanediol and 60 to 90 mole percent of the residues of ethylene glycol.

16. The oxygen-scavenging composition of claim 13 wherein said diol residues comprise 10 to 99 mole percent of the residues of 1,4-cyclohexanediol, 0 to 90 mole percent of the residues of ethylene glycol, and 1 to 25 mole percent of the residues of diethylene glycol.

17. The oxygen-scavenging composition of claim 13 wherein said diol residues comprise 50 to 90 mole percent of the residues of 1,4-cyclohexanediol and 10 to 50 mole percent of ethylene glycol.

18. The oxygen-scavenging composition of claim 1 wherein said second component (ii) comprises a homogeneous blend comprising a first polyamide, comprising aromatic residues, and a second polyamide comprising aliphatic residues.

19. The oxygen-scavenging composition of claim 18 wherein said homogeneous blend comprises a first polyamide comprising the residues of m-xylylenediamine and adipic acid, and said second polyamide comprises the residues of at least one aliphatic or cycloaliphatic monomer selected from adipic acid, pimelic acid, suberic acid, azelaic acid, sebacic acid, undecane-dioic acid, dodecanedioic acid, caprolactam, butyrolactam, 11-amino-undecane-dioic acid, and hexamethylene diamine.

20. The oxygen-scavenging composition of claim 18 wherein said second polyamide comprises at least one polyamide selected from nylon 4; nylon 6; nylon 9; nylon 11; nylon 12; nylon 6,6; nylon 5,10; nylon 6,12; nylon 6,11; nylon 10,12; and combinations thereof.

21. The oxygen-scavenging composition of claim 20 wherein said second polyamide comprises nylon 6, nylon 6,6, or blends thereof.

22. The oxygen-scavenging composition of claim 20 wherein said homogeneous blend comprises 20 mmole/Kg or less of terminal amine groups.

23. The oxygen-scavenging composition of claim 1 wherein said metal is selected from copper, nickel, cobalt, iron, manganese, and combinations thereof.

24. The oxygen-scavenging composition of claim 23 which contains 10 to 500 parts per million by weight of said metal, based on the total weight of said composition.

25. The oxygen-scavenging composition of claim 24 which comprises 50 to 300 parts per million of said metal.

26. The oxygen-scavenging composition of claim 22 wherein said metal is cobalt and said at least one thermoplastic polymer comprises a polyester comprising: (a) diacid residues comprising at least 80 mole percent, based on the total diacid residues, of the residues of at least one dicarboxylic acid selected from terephthalic acid, isophthalic acid, naphthalenedicarboxylic acid, and 1,4-cyclohexanedicarboxylic acid, and 0 to 20 mole percent of the residues of at least one modifying dicarboxylic acid having 2 to 20 carbon atoms; and (b) diol residues comprising at least 80 mole percent, based on the total moles of diol residues, of the residues of at least one diol selected from ethylene glycol, 1,4-cyclohexanediol; neopentyl glycol, diethylene glycol, 1,3-propanediol, 1,4-butanediol, and 2,2,4,4-tetramethyl-1,3-cyclobutanediol; and from 0 to 20 mole percent of the residues of at least one modifying diol having from 3 to 16 carbons.

27. The oxygen-scavenging composition of claim 26 wherein said diacid residues comprise the residues of one or more dicarboxylic acids selected from terephthalic acid, isophthalic acid, or combinations thereof, and said diol residues comprise the residues of one or more diols selected from 1,4-cyclohexanediol, neopentyl glycol, ethylene glycol, and combinations thereof.
28. The oxygen-scavenging composition of claim 26 wherein said diacid residues comprise 60 to 100 mole percent of the residues of terephthalic acid and 0 to 40 mole percent of the residues of isophthalic acid and said diol residues comprise 100 mole percent of the residues of 1,4-cyclohexanediol.

29. The oxygen-scavenging composition of claim 26 wherein said diacid residues comprise 100 mole percent terephthalic acid.

30. The oxygen-scavenging composition of claim 26 wherein said diacid residues comprise 80 to 100 mole percent terephthalic acid and said diol residues comprise 50 to 90 mole percent 1,4-cyclohexanediol and 10 to 50 mole percent neopentyl glycol.

31. The oxygen-scavenging composition of claim 26 wherein said diacid residues comprise 100 mole percent terephthalic acid and said diol residues comprise 10 to 40 mole percent 1,4-cyclohexanediol and 60 to 90 mole percent ethylene glycol.

32. The oxygen-scavenging composition of claim 26 wherein said diol residue comprise 10 to 99 mole percent of 1,4-cyclohexanediol, 0 to 90 mole percent of ethylene glycol, and 1 to 25 mole percent of diethylene glycol.

33. The oxygen-scavenging composition of claim 26 wherein said diol residues comprise 50 to 90 mole percent 1,4-cyclohexanediol and 10 to 50 mole percent ethylene glycol.

34. The oxygen-scavenging composition of claim 26 wherein said at least one thermoplastic polymer further comprises a homogeneous blend of said polyester and a polycarbonate comprising the residues of bisphenol A.

35. The oxygen-scavenging composition of claim 34 wherein said polyester and said polycarbonate are branched.

36. The oxygen-scavenging composition of claim 35 wherein said polyester further comprises 0.1 to 2 mole%, based on the total diacid residues, of the residues of at least one branching agent selected from trimellitic acid, trimellitic anhydride, and pyromellitic dianhydride.

37. The oxygen-scavenging composition of claim 34 wherein said diacid residues comprise the residues of one or more dicarboxylic acids selected from terephthalic acid, isophthalic acid, or combinations thereof, and said diol residues comprise the residues of one or more diols selected from 1,4-cyclohexanediol, neopentyl glycol, ethylene glycol, and combinations thereof.

38. The oxygen-scavenging composition of claim 34 wherein said diacid residues comprise 60 to 100 mole percent of the residues of terephthalic acid and 0 to 40 mole percent of the residues of isophthalic acid and said diol residue comprises 100 mole percent of the residues of 1,4-cyclohexanediol.

39. The oxygen-scavenging composition of claim 34 wherein said diacid residues comprise 100 mole percent terephthalic acid.

40. The oxygen-scavenging composition of claim 34 wherein said diacid residues comprise 80 to 100 mole percent terephthalic acid and said diol residues comprise 50 to 90 mole percent 1,4-cyclohexanediol and 10 to 50 mole percent neopentyl glycol.

41. The oxygen-scavenging composition of claim 34 wherein said diacid residues comprise 100 mole percent terephthalic acid and said diol residues comprise 10 to 40 mole percent 1,4-cyclohexanediol and 60 to 90 mole percent ethylene glycol.

42. The oxygen-scavenging composition of claim 39 wherein said diol residues comprise 10 to 99 mole percent of 1,4-cyclohexanediol, 0 to 90 mole percent of ethylene glycol, and 1 to 25 mole percent of diethylene glycol.

43. The oxygen-scavenging composition of claim 39 wherein said diol residues comprise 50 to 90 mole percent 1,4-cyclohexanediol and 10 to 50 mole percent ethylene glycol.

44. A shaped article comprising the oxygen-scavenging composition of any one of claims 2, 8, 20, or 41.
EP 1 869 122 B1

45. The shaped article of claim 44 which is formed by extrusion, calendering, thermoforming, blow-molding, extrusion blow-molding, injection molding, compression molding, casting, drafting, tentering, or blowing.

46. The shaped article of claim 45 which is a sheet, film, tube, preform, or bottle.

47. The shaped article of claim 46 which is a bottle.

48. The shaped article of claim 46 which has from 2 to 7 layers.

Patentansprüche

1. Eine Sauerstofffängerzusammensetzung, umfassend:

(A) eine unvermischbare Mischung umfassend

(i) erste Komponente umfassend mindestens ein thermoplastisches Polymer ausgewählt aus Polyester, Polycarbonat, Polyarylat und homogene Mischungen davon;

(ii) eine zweite Komponente umfassend eine transamidierte, homogene Mischung von mindestens zwei Polyamiden;

wobei die genannte zweite Komponente (ii) und die genannte erste Komponente (i) eine Differenz im Brechungsindex, RI (zweite Komponente) - RI (erste Komponente), von 0,006 bis -0,0006 aufweisen und die genannte unvermischbare Mischung einen Prozentsatz der Transmission von mindestens 75 % und eine Trübung von 10 % oder weniger hat; und

(B) mindestens ein Metall ausgewählt aus den Gruppen 3-12, Reihen 4-6 des Periodensystems der Elemente,

wobei der Brechungsindex bei einer Wellenlänge von 633 nm mit Hilfe eines Metricon Prism Coupler™ Model 2010 Refraktometers bestimmt wird, basiert auf dem Mittelwert der Brechungsindices, gemessen in 3 orthogonalen Richtungen (Extrusion oder Dehnung, Querrichtung und Dicke),

wobei die Trübung und Transmission gemäß ASTM D 1003 Methode auf einem Film, Folie, Plaque oder einem 1x1 cm Bereich eines Gegenstandes gemessen wird, die aus der Zusammensetzung hergestellt sind, mit einer Dicke von 3,175 mm (1/8 inch) oder weniger, und

wobei der Begriff "unvermischbar" eine Mischung bezeichnet, die mindestens 2 statistisch vermischte Phasen zeigt und mehr als ein T<sub>g</sub> aufweist.

2. Sauerstofffängerzusammensetzung nach Anspruch 1, wobei die genannte zweite Komponente (ii) eine homogene, transamidierte Mischung von mindestens zwei Polyamiden ist, gebildet durch Kontaktieren der genannten mindestens zwei Polyamide bei einer Temperatur von etwa 290°C bis etwa 340°C.

3. Sauerstofffängerzusammensetzung nach Anspruch 2, wobei das genannte Kontaktieren durch Schmelzmischen oder Extrudieren durchgeführt wird.

4. Sauerstofffängerzusammensetzung nach Anspruch 2, welche umfasst 5 bis 99 Gew.-% der genannten ersten Komponente (i) und 95 bis 1 Gew.-% der genannten zweiten Komponente (ii), bezogen auf das Gesamtgewicht der genannten Sauerstofffängerzusammensetzung.

5. Sauerstofffängerzusammensetzung nach Anspruch 4, welche umfasst 50 bis 99 Gew.-% der genannten ersten Komponente (i) und 50 bis 1 Gew.-% der genannten zweiten Komponente (ii), bezogen auf das Gesamtgewicht der genannten Sauerstofffängerzusammensetzung.

6. Sauerstofffängerzusammensetzung nach Anspruch 5, welche umfasst 70 bis 99 Gew.-% der genannten ersten Komponente (i) und 30 bis 1 Gew.-% der genannten zweiten Komponente (ii), bezogen auf das Gesamtgewicht der genannten Sauerstofffängerzusammensetzung.

7. Sauerstofffängerzusammensetzung nach Anspruch 1, wobei die genannte zweite Komponente (ii) und die genannte erste Komponente (i) eine Differenz im Brechungsindex, RI (zweite Komponente) - RI (erste Komponente), von 0,005 bis -0,0006 aufweisen.
8. Sauerstofffängerzusammensetzung nach Anspruch 1, wobei die genannte erste Komponente (i) umfasst ein Poly-
ester umfassend: (a) Disäure-Reste umfassend mindestens 80 Mol-%, bezogen auf die gesamte Disäure-Reste, der
Reste mindestens einer Dicarbonsäure ausgewählt aus Terephthalsäure, Isophthalsäure, Naphthalindicarbonsäure
und 1,4-Cyclohexandicarbonsäure, und 0 bis 20 Mol-% der Reste mindestens einer modifizierenden Dicarbonsäure
mit 2 bis 20 Kohlenstoffatomen; und (b) Diol-Reste umfassend mindestens 80 Mol-%, bezogen auf die gesamte Mole
der Diol-Reste, der Reste mindestens eines Diols, ausgewählt aus Ethylenlykol, 1,4-Cyclohexandimethanol; Neo-
pentylglykol, Diethylenglykol, 1,3-Propandiol, 1,4-Butandiol und 2,2,4,4-Tetramethyl-1,3-cyclobutandiol; und von 0
bis 20 Mol-% der Reste eines modifizierenden Diols, das von 3 bis 16 Kohlenstoffe enthält.

9. Sauerstofffängerzusammensetzung nach Anspruch 8, wobei die genannte modifizierende Dicarbonsäure ausge-
wählt aus Bipheryl-4,4'-dicarbonsäure, 1,4-Naphthalindicarbonsäure, 1,5-Naphthalindicarbonsäure, 2,6-Naph-
thalindicarbonsäure, 2,7-Naphthalindicarbonsäure, 4,4'-Oxybenzoësäure, trans-4,4'-Stilbendicarbonsäure, Oxal-
säure, Malonsäure, Bernsteinäsäure, Glutarsäure, Adipinsäure, Pimelinsäure, Kortsäure, Azelainsäure und Seba-
cinsäure ist; und das genannte modifizierende Diol ausgewählt aus 1,2-Propandiol, 1,3-Propandiol, 1,4-Butandiol,
1,5-Pentandiol, 1,6-Hexandiol, 1,4-Cyclohexandimethanol, p-Xylylenglykol, Neopentylglykol, Polyethylenglykol,
Diethylenglykol, Polytetramethylenglykol und 2,2,4,4-Tetramethyl-1,3-cyclobutandiol ist.

11. Sauerstofffängerzusammensetzung nach Anspruch 8, welche umfasst ferner 0,1 bis 2 Mol-%, bezogen auf die
gesamte Disäure-Reste, der Reste mindestens eines Verzweigungsmittele ausgewählt aus Trimellithsäure, Trimel-
litsäureanhydrid und Pyromellitsäureanhydrid.

14. Sauerstofffängerzusammensetzung nach Anspruch 8, wobei die genannten Disäure-Reste 80 bis 100 Mol-% der
Reste von Terephthalsäure und 0 bis 40 Mol-% der Reste von Isophthalsäure umfassen und der genannte Diol-
Rest 100 Mol-% der Reste von 1,4-Cyclohexandimethanol umfasst.

15. Sauerstofffängerzusammensetzung nach Anspruch 8, wobei die genannte Diol-Reste 100 Mol-% der Reste von
1,4-Cyclohexandimethanol 10 bis 50 Mol-% der Reste von Neopentylglykol umfassen.

16. Sauerstofffängerzusammensetzung nach Anspruch 13, wobei die genannten Diol-Reste 10 bis 99 Mol-% der Reste
von 1,4-Cyclohexandimethanol 0 bis 90 Mol-% der Reste von Ethylenlykol und 1 bis 25 Mol-% der Reste von
Diethylenglykol umfassen.

17. Sauerstofffängerzusammensetzung nach Anspruch 13, wobei die genannte Diol-Reste 50 bis 90 Mol-% von 1,4-
Cyclohexandimethanol 10 bis 50 Mol-% von Ethylenlykol umfassen.

18. Sauerstofffängerzusammensetzung nach Anspruch 1, wobei die genannte zweite Komponente (ii) umfasst eine
homogene Mischung umfassend ein erstes Polyamid, umfassend aromatische Reste, und ein zweites Polyamid
umfassend aliphatische Reste.

19. Sauerstofffängerzusammensetzung nach Anspruch 18, wobei die genannte homogene Mischung umfasst ein erstes
Polyamid umfassend die Reste von m-Xylylendiamin und Adipinsäure, und das genannte zweite Polyamid die Reste
mindestens eines aliphatischen oder cycloaliphatischen Monomers umfasst, ausgewählt aus Adipinsäure, Pimelin-
säure, Korksäure, Azelainsäure, Sebacinsäure, Undecandisäure, Dodecandisäure, Caprolactam, Butyrolactam, 11-
Amino-undecandisäure, und Hexamethyldiamin.
20. Sauerstofffängerzusammensetzung nach Anspruch 18, wobei das genannte zweite Polyamid mindestens ein Polyamid umfasst, ausgewählt aus Nylon 4; Nylon 6; Nylon 9; Nylon 11; Nylon 12; Nylon 6,6; Nylon 5,10; Nylon 6,12; Nylon 6,11; Nylon 10,12; und Kombinationen davon.

21. Sauerstofffängerzusammensetzung nach Anspruch 20, wobei das genannte zweite Polyamid Nylon 6, Nylon 6,6, oder Mischungen davon umfasst.

22. Sauerstofffängerzusammensetzung nach Anspruch 20, wobei die genannte homogene Mischung 20 mMol/kg oder weniger Aminoendgruppen umfasst.

23. Sauerstofffängerzusammensetzung nach Anspruch 1, wobei das genannte Metall aus Kupfer, Nickel, Kobalt, Eisen, Mangan, und Kombinationen davon ausgewählt ist.


25. Sauerstofffängerzusammensetzung nach Anspruch 24, welche von 50 bis 300 Gewichtsteile pro Million des genannten Metalls umfasst.

26. Sauerstofffängerzusammensetzung nach Anspruch 22, wobei das genannte Metall Kobalt ist und das genannte mindestens ein thermoplastisches Polymer umfasst ein Polyester umfassend: (a) Disäure-Reste umfassend mindestens 80 Mol-%, bezogen auf die gesamt Disäure-Reste, der Reste mindestens einer Dicarbonsäure ausgewählt aus Terephthalsäure, Isophthalsäure, Naphthalindicarbonsäure und 1,4-Cyclohexandicarbonsäure, und 0 bis 20 Mol-% der Reste mindestens einer modifizierenden Dicarbonsäure mit 2 bis 20 Kohlenstoffatomen; und (b) Diol-Reste umfassend mindestens 80 Mol-%, bezogen auf die gesamt Mole der Diol-Reste, der Reste mindestens eines Diols, ausgewählt aus Ethylenglykol, 1,4-Cyclohexandiethanol; Neopentylglykol, Diethylglykol, 1,3-Propandiol, 1,4-Butandiol und 2,2,4,4-Tetramethyl-1,3-cyclobutandiol; und von 0 bis 20 Mol-% der Reste mindestens eines modifizierenden Diols, das von 3 bis 16 Kohlenstoffe enthält.

27. Sauerstofffängerzusammensetzung nach Anspruch 26, wobei die genannten Disäure-Reste die Reste einer oder mehrerer Dicarbonsäuren umfassen, ausgewählt aus Terephthalsäure, Isophthalsäure oder Kombinationen davon, und die genannten Diol-Reste die Reste eines oder mehrerer Diole umfassen, ausgewählt aus 1,4-Cyclohexandimethanol; Neopentylglykol, Ethylenglykol und Kombinationen davon.

28. Sauerstofffängerzusammensetzung nach Anspruch 26, wobei die genannten Disäure-Reste 60 bis 100 Mol-% der Reste von Terephthalsäure und 0 bis 40 Mol-% der Reste von Isophthalsäure umfassen und die genannten Diol-Reste 100 Mol-% der Reste von 1,4-Cyclohexandiethanol umfassen.

29. Sauerstofffängerzusammensetzung nach Anspruch 26, wobei die genannten Disäure-Reste 100 Mol-% von Terephthalsäure umfassen.

30. Sauerstofffängerzusammensetzung nach Anspruch 26, wobei die genannten Disäure-Reste 80 bis 100 Mol-% der Reste von Terephthalsäure und die genannten Diol-Reste 50 bis 90 Mol-% von 1,4-Cyclohexandiethanol und 10 bis 50 Mol-% von Neopentylglykol umfassen.

31. Sauerstofffängerzusammensetzung nach Anspruch 26, wobei die genannten Disäure-Reste 100 Mol-% von Terephthalsäure umfassen und die genannten Diol-Reste 10 bis 40 Mol-% von 1,4-Cyclohexandiethanol und 60 bis 90 Mol-% von Ethylenglykol umfassen.

32. Sauerstofffängerzusammensetzung nach Anspruch 26, wobei die genannten Diol-Reste 10 bis 99 Mol-% von 1,4-Cyclohexandiethanol, 0 bis 90 Mol-% von Ethylenglykol und 1 bis 25 Mol-% von Diethylglykol umfassen.

33. Sauerstofffängerzusammensetzung nach Anspruch 26, wobei die genannten Diol-Reste 50 bis 90 Mol-% von 1,4-Cyclohexandiethanol und 10 bis 50 Mol-% von Ethylenglykol umfassen.

34. Sauerstofffängerzusammensetzung nach Anspruch 26, wobei das genannte mindestens ein thermoplastisches Polymer umfasst ferner eine homogene Mischung aus dem genannten Polyester und einem Polycarbonat umfassend die Reste von Bisphenol A.
35. Sauerstofffängerzusammensetzung nach Anspruch 34, wobei das genannte Polyester und das genannte Polycarbonat verweigt sind.

36. Sauerstofffängerzusammensetzung nach Anspruch 35, wobei das genannte Polyester umfasst ferner 0,1 bis 2 Mol-%, bezogen auf die gesamten Disäure-Reste, der Reste mindestens eines Verzweigungsmittels ausgewählt aus Trimellithsäure, Trimellithsäureanhydrid und Pyromellithsäuredianhydrid.

37. Sauerstofffängerzusammensetzung nach Anspruch 34, wobei die genannten Disäure-Reste die Reste einer oder mehrerer DiCarbonsäuren umfassen, ausgewählt aus Terephthalsäure, Isothopalsäure oder Kombinationen davon, und die genannten Diol-Reste die Reste eines oder mehrerer Diole umfassen, ausgewählt aus 1,4-Cyclohexandimethanol, Neopentylglykol, Ethylenglykol und Kombinationen davon.

38. Sauerstofffängerzusammensetzung nach Anspruch 34, wobei die genannten Disäure-Reste 60 bis 100 Mol-% der Reste von Terephthalsäure und 0 bis 40 Mol-% der Reste von Isothopalsäure umfassen und der genannte Diol-Rest 100 Mol-% der Reste von 1,4-Cyclohexandimethanol umfasst.

39. Sauerstofffängerzusammensetzung nach Anspruch 34, wobei die genannten Disäure-Reste 100 Mol-% von Terephthalsäure umfassen.

40. Sauerstofffängerzusammensetzung nach Anspruch 34, wobei die genannten Disäure-Reste 80 bis 100 Mol-% von Terephthalsäure umfassen und die genannten Diol-Reste 50 bis 90 Mol-% von 1,4-Cyclohexandimethanol und 10 bis 50 Mol-% von Neopentylglykol umfassen.

41. Sauerstofffängerzusammensetzung nach Anspruch 34, wobei die genannten Disäure-Reste 100 Mol-% von Terephthalsäure umfassen und die genannten Diol-Reste 10 bis 40 Mol-% von 1,4-Cyclohexandimethanol und 60 bis 90 Mol-% von Ethylenglykol umfassen.

42. Sauerstofffängerzusammensetzung nach Anspruch 39, wobei die genannten Diol-Reste 10 bis 99 Mol-% von 1,4-Cyclohexandimethanol, 0 bis 90 Mol-% von Ethylenglykol und 1 bis 25 Mol-% von Diethylenglykol umfassen.

43. Sauerstofffängerzusammensetzung nach Anspruch 39, wobei die genannten Diol-Reste 50 bis 90 Mol-% von 1,4-Cyclohexandimethanol und 10 bis 50 Mol-% von Ethylenglykol umfassen.

44. Ein geformter Gegenstand umfassend die Sauerstofffängerzusammensetzung eines der Ansprüche 2, 8, 20 oder 41.


46. Geformter Gegenstand nach Anspruch 45, welcher eine Folie, Film, Tube, Vorform oder Flasche ist.

47. Geformter Gegenstand nach Anspruch 46, welcher eine Flasche ist.


Revendications

1. Composition désoxygénante comprenant :

(A) un mélange non miscible comprenant

   (i) un premier composant comprenant au moins un polymère thermoplastique choisi parmi un polyester, un polycarbonate, un polyarylate et des mélanges homogènes de ceux-ci ;

   (ii) un deuxième composant comprenant un mélange homogène transamidé d’au moins deux polyamides ;

   dans lequel ledit deuxième composant (ii) et ledit premier composant (i) ont une différence d’indice de réfraction, IR (deuxième composant)-IR (premier composant), de 0,006 à -0,0006 et ledit mélange non miscible a un
2. Composition désoxygénante selon la revendication 1, dans laquelle ledit deuxième composant (ii) est un mélange homogène transamidé d’au moins deux polyamides formé par la mise en contact desdits au moins deux polyamides à une température d’environ 290 °C à environ 340 °C.

3. Composition désoxygénante selon la revendication 2, dans laquelle ladite mise en contact est effectuée par mélangeage à l’état fondu ou extrusion.

4. Composition désoxygénante selon la revendication 2 qui comprend 5 à 99 pour cent en poids dudit premier composant (i) et 95 à 1 pour cent en poids dudit deuxième composant (ii), sur la base du poids total de ladite composition désoxygénante.

5. Composition désoxygénante selon la revendication 4 qui comprend 50 à 99 pour cent en poids dudit premier composant (i) et 50 à 1 pour cent en poids dudit deuxième composant (ii), sur la base du poids total de ladite composition désoxygénante.

6. Composition désoxygénante selon la revendication 5 qui comprend 70 à 99 pour cent en poids dudit premier composant (i) et 30 à 1 pour cent en poids dudit deuxième composant (ii), sur la base du poids total de ladite composition désoxygénante.

7. Composition désoxygénante selon la revendication 1, dans laquelle ledit deuxième composant (ii) et ledit premier composant (i) ont une différence d’indice de réfraction, IR (deuxième composant)-IR (premier composant), de 0,005 à -0,0006.

8. Composition désoxygénante selon la revendication 1, dans laquelle ledit deuxième composant (ii) est un mélange homogène transamidé d’au moins deux polyamides formé par la mise en contact desdits au moins deux polyamides dans laquelle l’indice de réfraction est déterminé à une longueur d’onde de 633 nm en utilisant un réfractomètre Metricon Prism Coupler™ modèle 2010 sur la base de la moyenne des indices de réfraction mesurés dans 3 directions orthogonales (extrusion ou étirement, transversale et épaisseur), dans laquelle le trouble et la transmittance sont mesurés selon la méthode ASTM D1003 sur un film, une feuille, une plaque ou une coupe de 1 x 1 cm d’un article fabriqué à partir de la composition ayant une épaisseur de 3,175 mm (1/8 pouce) ou moins, et dans laquelle le terme « non miscible » désigne un mélange qui montre au moins 2 phases, mélangées de façon aléatoire, et présente plus d’une Tg.

9. Composition désoxygénante selon la revendication 8, dans laquelle ledit acide dicarboxylique modificateur est choisi parmi l’acide 4,4’-biphényldicarboxylique, l’acide 1,4-naphtalènedicarboxylique, l’acide 1,5-naphtalènedicarboxylique, l’acide 2,6-naphtalènedicarboxylique, l’acide 2,7-naphtalènedicarboxylique, l’acide 4,4’-oxybenzoïque, l’acide trans-4,4’-stilbènedicarboxylique, l’acide orthoïque, l’acide malonique, l’acide succinique, l’acide glutarique, l’acide adique, l’acide pimélique, l’acide azélaïque et l’acide sébacique ; et ledit diol modificateur est choisi parmi le 1,2-propanediol, le 1,3-propanediol, le 1,4-butanediol, le 1,5-pentanediol, le 1,6-hexanediol, le 1,4-cyclohexanediéthanol, le p-xylène glycol, le néopentyl glycol, le polyéthylène glycol, le diéthylène glycol, le poly-tétraméthyléthylé glycol et le 2,2,4,4-tétraméthyl-1,1-cyclobutanediol ; et de 0 à 20 pour cent en moles d’au moins un diol modificateur possédant de 3 à 16 atomes de carbone.

10. Composition désoxygénante selon la revendication 8, dans laquelle lesdits résidus diacides comprennent les résidus d’un ou plusieurs acide(s) dicarboxylique(s) choisi(s) parmi l’acide téréphtalique, l’acide isophthalique, ou des combinaisons de ceux-ci, et lesdits résidus diols comprennent les résidus d’un ou plusieurs diol(s) choisi(s) parmi le 1,4-cyclohexanediéthanol, le néopentyl glycol, l’éthylène glycol, et des combinaisons de ceux-ci.
11. Composition désoxygénante selon la revendication 8 qui comprend en outre 0,1 à 2 % en mole, sur la base du total des résidus diacides, des résidus d’au moins un agent de ramification choisi parmi l’acide trimellitique, l’anhydride trimellitique et le di-anhydride pyromellitique.

12. Composition désoxygénante selon la revendication 8, dans laquelle lesdits résidus diacides comprennent 60 à 100 pour cent en mole des résidus d’acide téraphthalique et 0 à 40 pour cent en mole des résidus d’acide isophthalique et ledit résidu diol comprend 100 pour cent en mole des résidus de 1,4-cyclohexanediméthanol.

13. Composition désoxygénante selon la revendication 8, dans laquelle lesdits résidus diacides comprennent 100 pour cent en mole des résidus d’acide téraphthalique.

14. Composition désoxygénante selon la revendication 8, dans laquelle lesdits résidus diacides comprennent 80 à 100 pour cent en mole des résidus d’acide téraphthalique et lesdits résidus diols comprennent 50 à 90 pour cent en mole des résidus de 1,4-cyclohexanediméthanol et 10 à 50 pour cent en mole des résidus de néopentyl glycol.

15. Composition désoxygénante selon la revendication 8, dans laquelle lesdits résidus diacides comprennent 100 pour cent en mole des résidus d’acide téraphthalique et ledit résidu diol comprend 10 à 40 pour cent en mole des résidus de 1,4-cyclohexanediol.

16. Composition désoxygénante selon la revendication 13, dans laquelle lesdits résidus diols comprennent 10 à 99 pour cent en mole des résidus de 1,4-cyclohexanediol, 0 à 90 pour cent en mole des résidus d’éthylène glycol, et 1 à 25 pour cent en mole des résidus diéthylène glycol.

17. Composition désoxygénante selon la revendication 13, dans laquelle lesdits résidus diols comprennent 50 à 90 pour cent en mole des résidus de 1,4-cyclohexanediol et 10 à 50 pour cent en mole des résidus d’éthylène glycol.

18. Composition désoxygénante selon la revendication 1, dans laquelle ledit deuxième composant (ii) comprend un mélange homogène comprenant un premier polyamide, comprenant des résidus aromatiques, et un deuxième polyamide comprenant des résidus aliphatiques.


20. Composition désoxygénante selon la revendication 18, dans laquelle ledit deuxième polyamide comprend au moins un polyamide choisi parmi le nylon 4 ; le nylon 6 ; le nylon 9 ; le nylon 11 ; le nylon 12 ; le nylon 6,6 ; le nylon 6,10 ; le nylon 6,12 ; le nylon 6,11 ; le nylon 10,12 ; et des combinaisons de ceux-ci.

21. Composition désoxygénante selon la revendication 20, dans laquelle ledit deuxième polyamide comprend du nylon 6, du nylon 6,6 ou des mélanges de ceux-ci.

22. Composition désoxygénante selon la revendication 20, dans laquelle ledit mélange homogène comprend 20 mmoles/kg ou moins de groupes amine terminaux.

23. Composition désoxygénante selon la revendication 1, dans laquelle ledit métal est choisi parmi le cuivre, le nickel, le cobalt, le fer, le manganèse et des combinaisons de ceux-ci.

24. Composition désoxygénante selon la revendication 23 qui contient 10 à 500 parties par million en poids dudit métal, sur la base du poids total de ladite composition.

25. Composition désoxygénante selon la revendication 24 qui comprend 50 à 300 parties par million en poids dudit métal.

26. Composition désoxygénante selon la revendication 22, dans laquelle ledit métal est le cobalt et ledit au moins un polymère thermoplastique comprend un polyester comprenant : (a) des résidus diacides comprenant au moins 80 pour cent en mole, sur la base du total des résidus diacides, des résidus d’au moins un acide dicarboxylique choisi
parmi l’acide téréphthalique, l’acide isophthalique, l’acide naphtalènedicarboxylique et l’acide 1,4-cyclohexanedicarboxylique, et 0 à 20 pour cent en mole des résidus d’au moins un acide dicarboxylique modificateur possédant de 2 à 20 atomes de carbone ; et (b) des résidus diols comprenant au moins 80 pour cent en mole, sur la base du total des moles de résidus diols, des résidus d’au moins un diol choisi parmi l’éthylène glycol, le 1,4-cyclohexanédiméthanol, le néopentyl glycol, le diéthylène glycol, le 1,3-propanediol, le 1,4-butanediol, et le 2,2,4,4-tétraméthyl-1,3-cyclobutanediol ; et de 0 à 20 pour cent en mole des résidus d’au moins un diol modificateur possédant de 3 à 16 atomes de carbone.

27. Composition désoxygénante selon la revendication 26, dans laquelle lesdits résidus diacides comprennent les résidus d’un ou plusieurs acide(s) dicarboxylique(s) choisi(s) parmi l’acide téréphthalique, l’acide isophthalique ou des combinaisons de ceux-ci, et lesdits résidus diols comprennent les résidus d’un ou plusieurs diol(s) choisi(s) parmi le 1,4-cyclohexanédiméthanol, le néopentyl glycol, l’éthylène glycol, et des combinaisons de ceux-ci.

28. Composition désoxygénante selon la revendication 26, dans laquelle lesdits résidus diacides comprennent 60 à 100 pour cent en mole des résidus d’acide téréphthalique et 0 à 40 pour cent en mole des résidus d’acide isophthalique et lesdits résidus diols comprennent 100 pour cent en mole des résidus de 1,4-cyclohexanédiméthanol.

29. Composition désoxygénante selon la revendication 26, dans laquelle lesdits résidus diacides comprennent 100 pour cent en mole d’acide téréphthalique.

30. Composition désoxygénante selon la revendication 26, dans laquelle lesdits résidus diacides comprennent 80 à 100 pour cent en mole d’acide téréphthalique et lesdits résidus diols comprennent 50 à 90 pour cent en mole de 1,4-cyclohexanédiméthanol et 10 à 50 pour cent en mole de néopentyl glycol.

31. Composition désoxygénante selon la revendication 26, dans laquelle lesdits résidus diacides comprennent 100 pour cent en mole d’acide téréphthalique et lesdits résidus diols comprennent 10 à 40 pour cent en mole de 1,4-cyclohexanédiméthanol et 60 à 90 pour cent en mole d’éthylène glycol.

32. Composition désoxygénante selon la revendication 26, dans laquelle lesdits résidus diacides comprennent 10 à 99 pour cent en mole de 1,4-cyclohexanédiméthanol, 0 à 90 pour cent en mole d’éthylène glycol et 1 à 25 pour cent en mole de diéthylène glycol.

33. Composition désoxygénante selon la revendication 26, dans laquelle lesdits résidus diacides comprennent 50 à 90 pour cent en mole de 1,4-cyclohexanédiméthanol et 10 à 50 pour cent en mole d’éthylène glycol.

34. Composition désoxygénante selon la revendication 26, dans laquelle ledit au moins un polymère thermoplastique comprend en outre un mélange homogène dudit polyester et d’un polycarbonate comprenant les résidus de bisphénol A.

35. Composition désoxygénante selon la revendication 34, dans laquelle ledit polyester et ledit polycarbonate sont ramifiés.

36. Composition désoxygénante selon la revendication 35, dans laquelle ledit polyester comprend 0,1 à 2 % en mole, sur la base du total des résidus acides, des résidus d’au moins un agent de ramification choisi parmi l’acide trimellitique, l’anhydride trimellitique et le dianhydride pyromellitique.

37. Composition désoxygénante selon la revendication 34, dans laquelle lesdits résidus diacides comprennent les résidus d’un ou plusieurs acide(s) dicarboxylique(s) choisi(s) parmi l’acide téréphthalique, l’acide isophthalique ou des combinaisons de ceux-ci, et lesdits résidus diols comprennent les résidus d’un ou plusieurs diol(s) choisi(s) parmi le 1,4-cyclohexanédiméthanol, le néopentyl glycol, l’éthylène glycol et des combinaisons de ceux-ci.

38. Composition désoxygénante selon la revendication 34, dans laquelle lesdits résidus diacides comprennent 60 à 100 pour cent en mole des résidus d’acide téréphthalique et 0 à 40 pour cent en mole des résidus d’acide isophthalique et ledit résidu diol comprend 100 pour cent en mole des résidus de 1,4-cyclohexanédiméthanol.

39. Composition désoxygénante selon la revendication 34, dans laquelle lesdits résidus diacides comprennent 100 pour cent en mole d’acide téréphthalique.
40. Composition désoxygénante selon la revendication 34, dans laquelle lesdits résidus diacides comprennent 80 à 100 pour cent en mole d’acide téréphtalique et lesdits résidus diols comprennent 50 à 90 pour cent en mole de 1,4-cyclohexanédiméthanol et 10 à 50 pour cent en mole de néopentyl glycol.

41. Composition désoxygénante selon la revendication 34, dans laquelle lesdits résidus diacides comprennent 100 pour cent en mole d’acide téréphtalique et lesdits résidus diols comprennent 10 à 40 pour cent en mole de 1,4-cyclohexanédiméthanol et 60 à 90 pour cent en mole d’éthylène glycol.

42. Composition désoxygénante selon la revendication 39, dans laquelle lesdits résidus diols comprennent 10 à 99 pour cent en mole de 1,4-cyclohexanédiméthanol, 0 à 90 pour cent en mole d’éthylène glycol et 1 à 25 pour cent en mole de diéthylène glycol.

43. Composition désoxygénante selon la revendication 39, dans laquelle lesdits résidus diols comprennent 50 à 90 pour cent en mole de 1,4-cyclohexanédiméthanol et 10 à 50 pour cent en mole d’éthylène glycol.

44. Article formé comprenant la composition désoxygénante selon l’une quelconque des revendications 2, 8, 20 ou 41.

45. Article formé selon la revendication 44 qui est formé par extrusion, calandrage, thermoformage, moulage par soufflage, moulage par extrusion-soufflage, moulage par injection, moulage par compression, coulée, étirage, ramage ou soufflage.

46. Article formé selon la revendication 45 qui est une feuille, un film, un tube, une préforme ou une bouteille.

47. Article formé selon la revendication 46 qui est une bouteille.

48. Article formé selon la revendication 46 qui comporte de 2 à 7 couches.
REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader’s convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 6211309 B [0033]
- US 5290631 A [0046]
- US 4598130 A [0049]
- US 5034502 A [0049] [0051]
- US 4374239 A [0049] [0051]
- US 2999835 A [0049]
- US 3028365 A [0049]
- US 3153008 A [0049]
- US 4321355 A [0051]
- US 3030335 A [0091]
- US 3317466 A [0091]
- US 4880592 A [0102]
- US 4427614 A [0102]
- WO 9311190 A [0135]
- US 5552469 A [0136]
- US 5578672 A [0136]

Non-patent literature cited in the description

- Mixing and Compounding of Polymers. Carl Hanser Verlag, 1994 [0081]